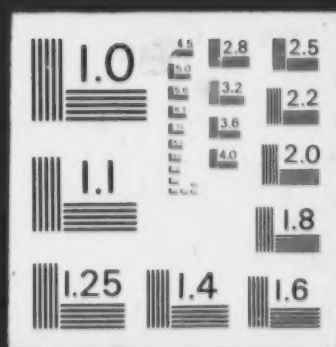


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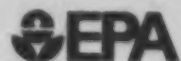
U.S. DEPARTMENT OF COMMERCE
National Technical Information Service

PB-290 895

Sewage Sludge Disposal of the City of Portland, Oregon

(U.S.) Environmental Protection Agency, Seattle, WA Region X

Feb 79



Environmental Impact Statement

Final

Sewage Sludge Disposal for the City of Portland Oregon



U.S. ENVIRONMENTAL PROTECTION AGENCY

REGION X

1200 SIXTH AVENUE
SEATTLE, WASHINGTON 98101



REPLY TO
ATTN OF: M/S 443

FEB 16 1979

To: All Interested Governmental Agencies, Public Groups and Citizens

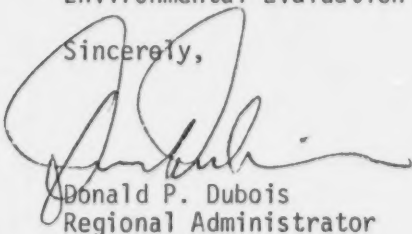
In compliance with Section 102(2)(c) of the National Environmental Policy Act of 1969, the Environmental Protection Agency has prepared a Final Environmental Impact Statement (EIS) entitled "Sewage Sludge Disposal for the City of Portland, Oregon. The Final EIS is enclosed for your review and any comments you may have.

After a careful review of all comments received on the Draft EIS and an evaluation of the environmental impacts associated with each of the alternatives considered, EPA recommends the implementation of Alternative A-1, which will result in the barging of liquid digested sludge from the City's Columbia Boulevard treatment plant to land disposal sites located in Morrow County, Oregon. EPA has determined that this alternative will provide a cost effective and environmentally sound solution for the proposed sludge reuse project.

Comments on this Final EIS and on EPA's recommendation are welcome. At the close of the 30-day review period, March 20, 1979, a final decision will be made concerning the award of construction grant funds to the City of Portland for implementation of the recommended project.

Please send any comments you may have or requests for additional copies of the EIS to EPA at the above address, attention: Roger K. Mochnick, Environmental Evaluation Branch, M/S 443.

Sincerely,



Donald P. Dubois
Regional Administrator

Attachment

PB290895

BIBLIOGRAPHIC INFORMATION

PB-290 895

Sewage Sludge Disposal for the City of Portland, Oregon.

Feb 79

PERFORMER: Environmental Protection Agency, Seattle, WA.
Region X.
EPA/910/9-78/050

Prepared by Jones and Stokes Associates, Inc., Sacramento, CA., Culp/Wesner/Culp, Santa Ana, CA., and Gruen Associates, Inc., San Francisco, CA.

Topic areas covered include: Environmental setting; Alternative sludge handling systems; Analysis of the environmental impacts of the alternatives; Unavoidable adverse impacts; Local short-term uses of the environment vs. maintenance and enhancement of long-term productivity; Irreversible and irretrievable commitments of resources; Unresolved issues.

KEYWORDS: *Sludge disposal, *Solid waste disposal,
*Environmental impact statements-final, *Sewage
sludge, *Portland(Oregon).

Available from the National Technical Information Service,
Springfield, Va. 22161

PRICE CODE: PC A14/MF A01

FINAL ENVIRONMENTAL IMPACT STATEMENT

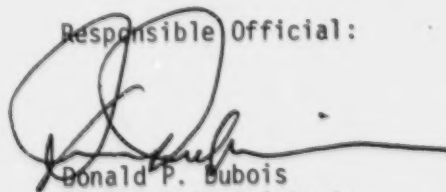
SEWAGE SLUDGE DISPOSAL
FOR THE
CITY OF PORTLAND, OREGON

Prepared by
U.S. Environmental Protection Agency
Region X
Seattle, WA 98101

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In Association With
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and
Gruen Gruen & Associates

Responsible Official:



Donald P. Dubois
Regional Administrator

JAN 31 1979

Date

PREFACE

On June 23, 1978 the Environmental Protection Agency (EPA) released a Draft Environmental Impact Statement (EIS) for a proposed sewage sludge reuse program for the City of Portland, Oregon. Under provisions contained in the Clean Water Act of 1978 (Public Law 92-217), EPA is authorized to provide 75 percent of the funds necessary to plan, design and implement such a program.

The Draft EIS, which evaluates the direct and indirect environmental impacts of a number of feasible reuse alternatives was submitted to Federal, State and local agencies as well as interested citizens for a 45-day review period. In addition, EPA conducted a number of public workshops and two public hearings to receive oral testimony on the Draft EIS. Comment letters received during the review period and a summary of comments received at the public hearings are included in this document on pages 241-314.

As a result of our evaluation of each of the alternatives, EPA elected to provide 75 percent grant funding for either of two cost and environmentally equivalent alternatives--Alternative A-1 (land application of liquid sludge in eastern Oregon) or C-1 (sludge drying for production of a fertilizer aid). After a review of the City's Facilities Plan, EPA's EIS, and other supporting documents the City selected Alternative A-1 as the long-term method of handling sludge generated at the City's Columbia Boulevard wastewater treatment plant. The salient factors considered by the City in selection of Alternative A-1 are contained in "Exhibit A" of the City of Portland Ordinance Number 146547 (Appendix I).

During the review period on the Draft EIS significant comments were received from the Oregon Department of Fish and Wildlife resulting in changes to Alternative A-1. Department comments stated that the two proposed barge offloading sites located in Morrow County, Oregon are extensively used by wildlife and use of these sites could cause significant impact. Because of these impacts, EPA has ruled out the use of Three- and Six-Mile Canyons for offloading facilities. A new site located north of Castle, Oregon has been selected for the facilities.

In addition, as a result of comments received from the Oregon State Historic Preservation Office (SHPO) (page 254) and as a result of an archaeological survey conducted by Oregon State University (OSU) (Appendix E), EPA has determined that additional survey work will be required. While the OSU study consisted of a survey of the offloading facilities and proposed pipeline route, no survey has yet been conducted

for the proposed disposal site. Therefore EPA will require an archaeological survey of the new identified offloading facility north of Castle, Oregon and the proposed disposal site. This requirement will be a part of the Step 2 (Design) grant offered to the City of Portland and will read as follows:

The grantee shall be responsible for conducting the activities necessary to identify cultural properties in the primary impact area of the project, to evaluate the effect of the project on the cultural properties, and to avoid or mitigate adverse effects on the cultural properties. These activities shall proceed as project design proceeds and as approved by EPA and the State Historic Preservation Officer. The grantee understands that such activities may include project relocation, archaeological salvage, or other appropriate measures. These activities shall be completed prior to the award of a subsequent Step 3 grant for the project.

Another significant comment was received from the U.S. Department of the Interior regarding the need for a groundwater monitoring program. To insure that this potential impact is fully evaluated EPA will also include as a condition to the City's Step 2 grant the requirement of a groundwater survey of the disposal area. The condition will read as follows:

The grantee shall be required to conduct a groundwater survey of the sludge disposal area. Upon completion, the survey will be submitted to the Oregon Department of Environmental Quality (DEQ) for review. The grantee understands that DEQ may require the preparation of a detailed groundwater monitoring program and contingency plan for the disposal site. This plan, if required, will be completed and approved by DEQ prior to the award of Step 3 grant funds for the project.

EPA releases this Final EIS for a public review period of 30-days. At the conclusion of the review period, EPA will consider all comments received prior to a final determination regarding the award of construction grant funds to the City for implementation of Alternative A-1. We would like to thank all of the agencies and interested citizens who have taken the time to provide us with their comments.

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SUMMARY

FINAL ENVIRONMENTAL STATEMENT -- SLUDGE DISPOSAL FOR THE CITY OF PORTLAND

Environmental Protection Agency
Region X
1200 Sixth Avenue
Seattle, Washington 98101

1. Type of Statement: Draft () Final (X)
2. Type of Action: Administrative (X) Legislative ()
3. Description of Action:

The objective of this project is to provide an institutionally and environmentally acceptable sludge disposal or reuse program for the City of Portland's Columbia Boulevard Wastewater Treatment Plant. This Final Environmental Impact Statement identifies alternatives for providing the city with a means of sludge disposal while at the same time achieving a beneficial reuse of the sludge.

The city is presently disposing of its primary and waste-activated sludge under an interim program of spraying on unoccupied lands in the Rivergate Industrial District and settling and storage in a sludge holding lagoon adjacent to the treatment plant. The Columbia Boulevard STP produces approximately 45 dry tons of sludge per day. The Tryon Creek and Kellogg (CCSD No. 1) wastewater treatment plants presently contribute sludge to the Columbia Boulevard plant or dispose of the sludge on the Rivergate area. Future development of the industrial district, filling of the sludge holding lagoons and filling of the St. Johns landfill make it necessary for the city to establish a long-term (20 years) means of sludge disposal. The city is presently increasing their capacity to anaerobically treat sludge and refurbishing the storage lagoons near the plant.

4. The Preferred Alternative:

The U. S. Environmental Protection Agency (EPA) elected to provide 75 percent grant funding for either of two cost and environmentally equivalent alternatives - Alternative A-1 (land application of liquid sludge in eastern Oregon) or

C-1 (sludge drying for production of a fertilizer aid) - as selected by the City of Portland. On September 27, 1978, the Portland City Council chose Alternative A-1 as a long-term method of sludge disposal. Factors considered by the city in selection of this alternative are contained in "Exhibit A" of the City of Portland Ordinance No. 146547 (Appendix I). Alternative A-1, which would involve barging sludge on the Columbia River to eastern Oregon, was recommended for implementation because of the relative simplicity and proven reliability of sludge pumping, barge transportation and land application systems.

Alternative A-1, as described in subsequent chapters, provides for the transportation of liquid digested sludge by barge up the Columbia River to Morrow County, where the sludge would be incorporated into the soil. Sludge treatment would be by anaerobic digestion for primary sludge and separate anaerobic digestion followed by lagooning for secondary sludge. Digested sludge would be pumped to a barge-loading facility on the Oregon Slough (Figure A) and then barged to Morrow County. At the Morrow County off-loading site, sludge would be pumped from the barge to a small lagoon and from there to a number of potential agricultural sites for soil incorporation (Figure B). Of the potential agricultural sites identified, the site preferred by the City of Portland is site "C" on Boeing Agri-Industrial property, southwest of the City of Boardman (Figure B).

Major impacts associated with barging liquid sludge to Morrow County (Alternative A) involve potential sludge spill hazard in the Columbia River (particularly in the Oregon Slough area), consumption of fuel, land form and soil alterations and natural vegetation and wildlife changes. In Morrow County liquid sludge will be stored in sludge lagoons prior to application on nearby agricultural lands. Methods of sludge application will be designed to minimize any problems associated with heavy metal loading, odors, vectors, and groundwater or surface water contamination. Large areas of irrigated and nonirrigated agricultural lands appear readily available in the Morrow County area. When spread on the land, liquid sludge will be a beneficial soil conditioner and light fertilizer (approximately 4 percent nitrogen). Samples of sludge analyzed during 1977 indicate zinc to be present in moderate quantities (2,400 ppm) and to be the heavy metal dictating the long-term sludge loading per acre and the expected life of the disposal sites.

Provision "b" of the City of Portland Ordinance No. 146547 directs the city engineer to negotiate for purchase of preferred agricultural sites in Morrow County for sludge disposal. This provision, however, also provides the city with the

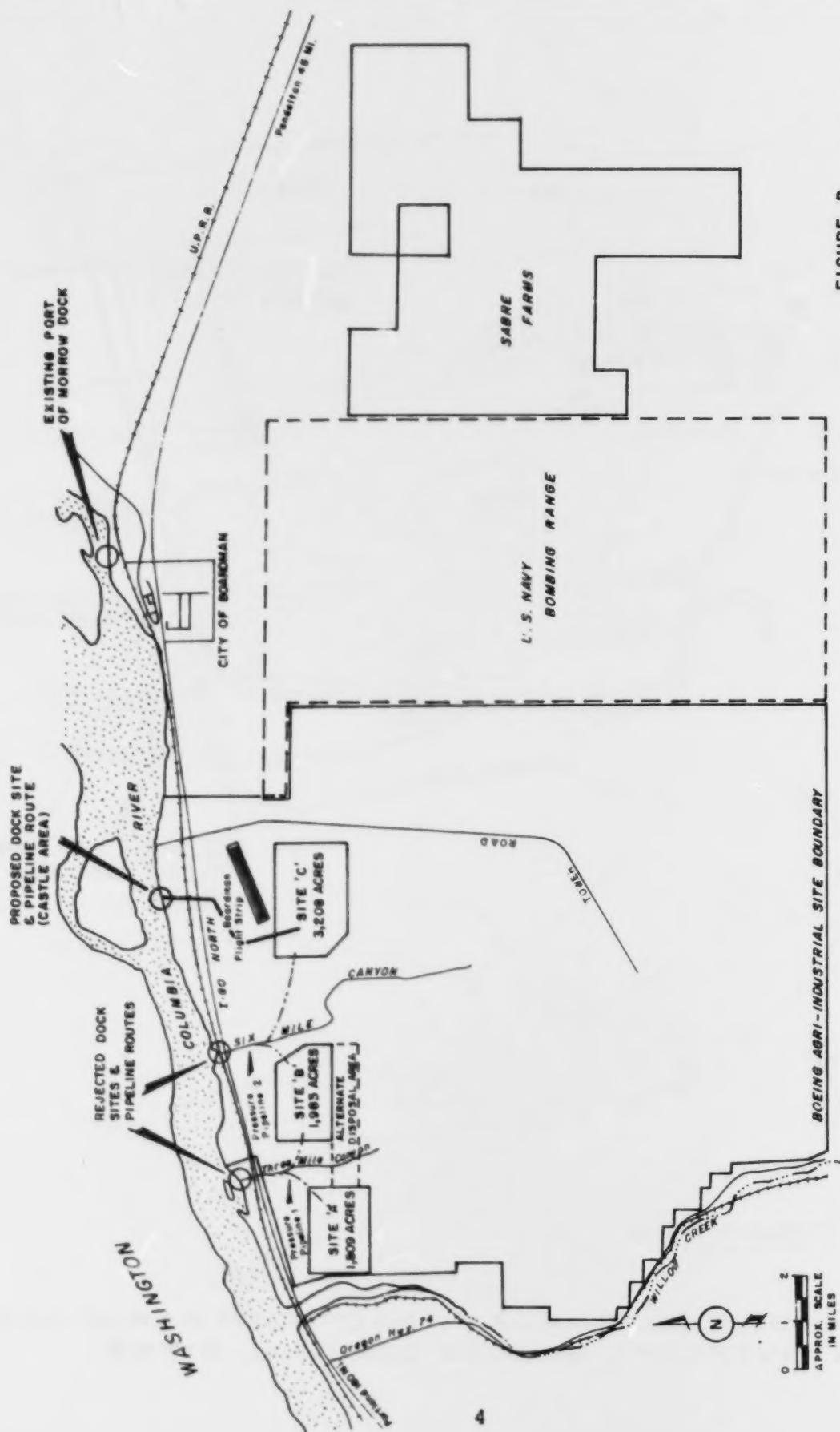


FIGURE B
PROPOSED SLUDGE APPLICATION
SITES, DOCK SITES &
PIPELINE ROUTES

option to accept bids from private concerns for independent sludge transportation and disposal at other locations in the Columbia River basin.

The Oregon Department of Fish and Wildlife expressed opposition to use of proposed off-loading sites and pipeline routes at Threemile and Sixmile Canyons due to extensive wildlife use of these areas (Figure B). A new area, north of Castel, Oregon, was suggested for sludge off-loading and pumping. Figure B shows a potential off-loading site and pipeline route in the Castle area, which would convey sludge to Site C on Boeing property. Due to concerns of the Department of Fish and Wildlife, EPA has ruled out use of Three- and Six-Mile Canyons and concurs with the Department as to the acceptability of a route to be located in the Castle area.

Vegetation within the proposed Castle off-loading site and pipeline route is typical of the area, consisting of native shrub-steppe vegetation, such as big sagebrush and rabbitbrush. The understory is composed of sparse native and introduced grasses and weedy species. Wildlife species associated with this plant community are listed in Appendix B.

Elevations rise from approximately 200 feet at the Columbia River to 550 feet at Site C. Finely textured soils are shallow over basalt bedrock. Basalt outcrops are evident at numerous locations.

Because of the sparse nature of vegetation at the off-loading site and pumping route, impacts on vegetation and associated wildlife would be relatively minor. To minimize adverse impacts on fish resources at the proposed off-loading site, The Department of Fish and Wildlife has suggested that alternative design features of the basin be evaluated at an early stage in the design phase.

Conditions required by EPA as part of the Step II grant to the City of Portland will include 1) a groundwater survey of those areas proposed for sludge application. Upon completion, the survey shall be submitted to the Oregon Department of Environmental Quality for a determination of whether or not groundwater monitoring will be required and 2) a detailed archeological and historical survey of all on- and off-loading sites, pipeline routes and sludge application sites chosen by the City of Portland.

5. Additional Alternatives Considered:

Additional alternatives evaluated in this EIS are Alternatives C-1 (sludge drying for production of a fertilizer aid) and D-1 (land application of liquid sludge in the

Willamette Valley). The No Action Alternative (continued use of Rivergate property and the Triangle Lake Sludge Lagoon for sludge disposal) is also evaluated. More detailed descriptions of these alternatives and their environmental impacts are presented in the Chapters on ALTERNATIVE SLUDGE HANDLING SYSTEMS and the ANALYSIS OF THE ENVIRONMENTAL IMPACTS OF THE ALTERNATIVES.

6. Unresolved Issues:

During the course of report preparation, it became clear that there are several key issues relative to the Portland sewage sludge disposal project. These issues are identified in the INTRODUCTION to this Draft EIS and are further discussed throughout the report. The resolutions to several of the issues are regulatory or institutional problems that must await further governmental action.

- o Review of heavy metal constituents of Portland sludge indicates moderate concentrations of zinc (2,408 mg/kg). Zinc concentrations are sufficiently high to reduce the projected life of application sites when sludge is applied at rates greater than 4.6 tons/acre, and to significantly increase the area of land needed to the year 2000. Three apparent options are available to deal with this loading: 1) additional source control of those industries contributing heavily to the metal loading, 2) utilization of larger amounts of land if sludge is used for agricultural purposes, and 3) disposal of sludge on a smaller area with no beneficial use and the possible long-term degradation of such land.
- o Preliminary review of test well monitoring results at the Rivergate industrial area indicates possible high amounts of zinc in the groundwater. No predisposal background data exist with which to compare the monitoring results. The acceptability of continued use of Rivergate as a disposal area should receive additional review and evaluation in reference to the monitoring data.
- o The use of Boeing agri-industry land or the U.S. Naval property in Boardman strictly for disposal of sludge (rather than for beneficial agricultural reuse) may be unacceptable to landowners and lessees in Morrow County.

FEDERAL AGENCIES

U. S. Department of Agriculture
U. S. Department of Defense
U. S. Department of Interior
U. S. Department of Health, Education and Welfare
U. S. Department of Housing and Urban Development
U. S. Department of Transportation
Federal Energy Office
National Marine Fisheries Service
Advisory Council on Historic Preservation

MEMBERS OF CONGRESS

Mark O. Hatfield	Al Ullman
U. S. Senate	U. S. House of Representatives
Robert W. Packwood	Les Aucoin
U. S. Senate	U. S. House of Representatives
	Robert Duncan
	U. S. House of Representatives

STATE AGENCIES

Robert W. Straub - Governor of Oregon
Jack Sumner - State Representative District 55
Oregon State Clearinghouse
Department of Environmental Quality

LOCAL AGENCIES & INTERESTED GROUPS

Columbia Region Association of Governments
Clackamas County Board of Commissioners
Clackamas County Department of Planning & Development
Clackamas County Health Department
Clackamas County Public Works Solid Waste Division
City of Oregon City
City of Oregon City Library
City of Oregon City Planning Department
Morrow County Department of Planning & Development
Morrow County Board of Commissioners
Morrow County Health Department

City of Boardman
City of Boardman Planning Commission
Multnomah County Board of Commissioners
Multnomah County Department of Planning & Development
Multnomah County Health Department
Oak Lodge Sanitary District
City of Portland
City of Portland Library
City of Portland Planning Department
Resource Conservation Company
Lee Engineering Enterprises
Cloudburst Research
Arthur Forsyth Co.
Boeing Agri-Ind. Co.
Western Farm Service, Inc. - Wheatland Division
Boardman Mobil Home
Lo-Ko Inc.
Wagon Trail Farm
Dehydro-Tech Corporation
League of Women Voters
National Wildlife Federation
1000 Friends of Oregon
Northwest Environmental Defense Center
OSPIRG
Oregon Environmental Council
Micheal B. Mathews - U.S.A.
Rupert Kennedy - Port of Morrow

INDIVIDUALS

Bill Culham
George D. Ward
Ronald Black

7. The Above Listed State, Federal and Local Agencies, as well as Other Interested Groups, were Invited to Comment on the Environmental Impact Statement.

INTRODUCTION

Purpose and Objectives

The National Environmental Policy Act of 1969 (NEPA) requires that agencies of the federal government prepare a detailed Environmental Impact Statement (EIS) on proposals for projects that may significantly affect the quality of the human environment. NEPA requires that agencies (in this case the Environmental Protection Agency [EPA]) include in their decision-making process all environmental aspects of proposed actions, the environmental impacts of the proposed project and its alternatives, and a discussion of ways to avoid or minimize adverse effects. The EIS is to be a "full disclosure" document and must follow specific regulations of the EPA as contained in 40 CFR, part 6, as published in the Federal Register, Volume 40, Number 72, April 14, 1975.

Because the City of Portland sewage sludge disposal project can be 75 percent funded by the EPA, as part of the Construction Grants Program authorized by the Federal Water Pollution Control Act Amendments of 1972 (PL 92-500), it requires NEPA action. After reviewing the facilities plan and environmental assessment submitted in September 1976 and March 1977 by the City of Portland, the EPA determined that the proposed project be separated into two phases -- Phase I - sludge processing (treatment) and Phase II - sludge handling and disposal. Pursuant to EPA regulations for NEPA actions a Negative Declaration was prepared for the Phase I project; however, EPA determined that an environmental impact statement was required for grant funding of Phase II.

Data for this EIS were compiled from numerous existing regional and local studies pertaining to Multnomah, Clackamas, Marion and Morrow Counties and the City of Portland. Field reconnaissance, literature review, personal contacts with involved agencies and individuals, and a marketing study all provided the data needed for this report. A listing of references and personal contacts appears in the bibliography.

The EIS process encourages public input into the decision-making process. A series of public information meetings were held March 1, 2 and 3, 1978, on the sludge disposal project and the EIS to both enlighten the public and to encourage comment on the project's impact. This EIS is prepared in draft form and shall be widely circulated for public comment. Announcement of an EPA public hearing on the project will

be made in the local press. The hearing is held to solicit public response to the Draft EIS. After the 45-day public comment period on the Draft EIS had elapsed, a grant fundable project will be described in the Final EIS. At the end of a 30-day comment period on the Final EIS, the EPA Regional Administrator will announce his decision concerning a grant award for the City of Portland.

Background of Past Events

Prior to 1968 the City of Portland's Columbia Boulevard sewage treatment plant operated as a primary treatment facility with a treatment capacity of 60 million gallons per day (mgd). In 1968 and again in 1972 the facility was expanded to a present capacity of 100 mgd secondary treatment. Prior to 1968 digested sludge was pumped to a series of lagoons for additional stabilization and storage. Solids were ultimately disposed of on drying beds located where the secondary facilities now exist.

With the addition of the secondary facilities plant sludge is treated by two methods -- anaerobic digestion for the stabilization of primary sludge and heat treatment/vacuum filtration for stabilization and dewatering of waste-activated sludge. Sludge is disposed of by a combination of three methods -- application of sludge to vacant industrial properties in Portland's Rivergate district, storage in the existing sludge lagoon (Triangle Lake) adjacent to the sewage treatment plant, and disposal in the City's St. Johns sanitary landfill, although the landfill site has not been used since. These disposal options have limited capacities.

In March 1977 the City's Department of Public Works prepared a report entitled Alternative Methods for the Disposal of Sewage Solids in which the need for additional sludge disposal capacity was discussed and alternative methods of disposal were evaluated.

On the basis of that document, the EPA and the Oregon Department of Environmental Quality approved a step 2, grant application (project design) for the construction of additional digesters and refurbishment of the existing sludge lagoons (Phase I). It was determined that the work proposed for Phase I would be necessary regardless of the method of conveyance and disposal ultimately chosen for Phase II.

Project Objectives and Environmental Goals and Constraints

An important element of any project is its objectives. Well-defined objectives are essential to establishing a rationale for a project and later providing guideposts to determine if identified alternatives are justifiable or viable.

The conveyance and disposal of sewage sludge from the Portland Columbia Boulevard sewage treatment plant is deemed a necessity because nearby storage and disposal space is lacking and because of institutional requirements -- that is, to meet EPA and DEQ regulations for wastewater solids disposal. The following project and environmental objectives appear relevant:

Project Objective

- o To provide an institutionally acceptable sewage sludge disposal program for the citizens of Portland.

Environmental Objectives

- o To minimize the adverse environmental effects of sludge treatment, transport and disposal.
- o To minimize the social-economic costs of sludge treatment, transport and disposal.
- o To provide for the beneficial reuse of sewage sludge.

Important Issues and Considerations: Phase II

Prior to and during the course of preparing this EIS, a number of key issues were identified that warranted discussion and, if possible, resolution.

The issues are identified below and are described and evaluated in the ENVIRONMENTAL SETTING and ENVIRONMENTAL IMPACT chapters of this report. Those issues that remain generally unresolved in this EIS will be discussed further in the Chapter entitled ISSUES TO BE RESOLVED. Of particular importance to this project are:

- o The interaction of the City of Portland's project with overall regional sludge disposal planning and the areawide 208 (CRAG) study.
- o Impacts associated with the land application of digested sludge in rural areas - i.e., the North Willamette Valley, Morrow County, Oregon.
- o Impacts to public lands, scenic areas, wildlife, etc., resulting from land conversion, haul roads and application equipment.
- o Effects of sludge containing heavy metals and other potential toxicants and pathogens on land, water and agricultural resources.

- o Impacts of a liquid sludge spill in the Columbia or Willamette Rivers, or on land transportation corridors.
- o Marketability of sterile dry sludge.
- o Capital and operation/maintenance costs of the alternatives.
- o Energy budget.
- o Secondary environmental and societal changes.
- o Possible conflicts between DEQ and EPA guidelines and the proposed project.

ENVIRONMENTAL SETTING

Project Planning Area

The planning area under consideration for processing conveyance and disposal of sewage sludge extends from the City of Portland east along the Columbia River Gorge to northcentral Oregon in Gilliam, Morrow and Sherman Counties, and south along the Willamette River into Clackamas, Marion, Multnomah, Polk, Washington and Yamhill Counties (Figure 1).

The Columbia Boulevard sewage treatment plant is located in Multnomah County in the vicinity of the Rivergate Industrial District, which is presently used for sludge disposal. Treated sewage sludge could be transported to numerous places within the planning area for disposal. Because of the dispersed nature of the project alternatives, the potential project is segmented in the description of the ENVIRONMENTAL SETTING into three parts: Portland, North Willamette Valley, and northcentral Oregon including the Columbia River. Each segment is described in general and in site-specific details responding to informational needs for evaluating sludge processing, conveyance and disposal operations.

The sites currently used for sludge disposal are in Portland. The no-action alternative for sludge disposal would continue present practices with disposal in Triangle Lake, the Multnomah County landfill and vacant industrial acreage in the Rivergate Industrial District north of Portland (Figure 2). The additional sites proposed for land disposal are located in Clackamas, Marion, Morrow and Multnomah Counties.

In Alternative A (land application for soil improvement in northcentral Oregon), digested sludge would be pumped through a pipeline running parallel to the Union Pacific railroad tracks or trucked from Columbia Boulevard STP and Triangle Lake to a barge loading facility on Oregon Slough (Figure 2). Sludge would then be barged upstream on the Columbia River to a dock unloading facility located in northern Morrow County at either Threemile or Sixmile Canyon west of the City of Boardman, or at the existing Port of Morrow docking facility east of the City of Boardman. Sludge would be conveyed by pipeline from the docks to storage and land application sites either on land controlled by Boeing, Sabre Farms or the U. S. Navy (Figure 3).

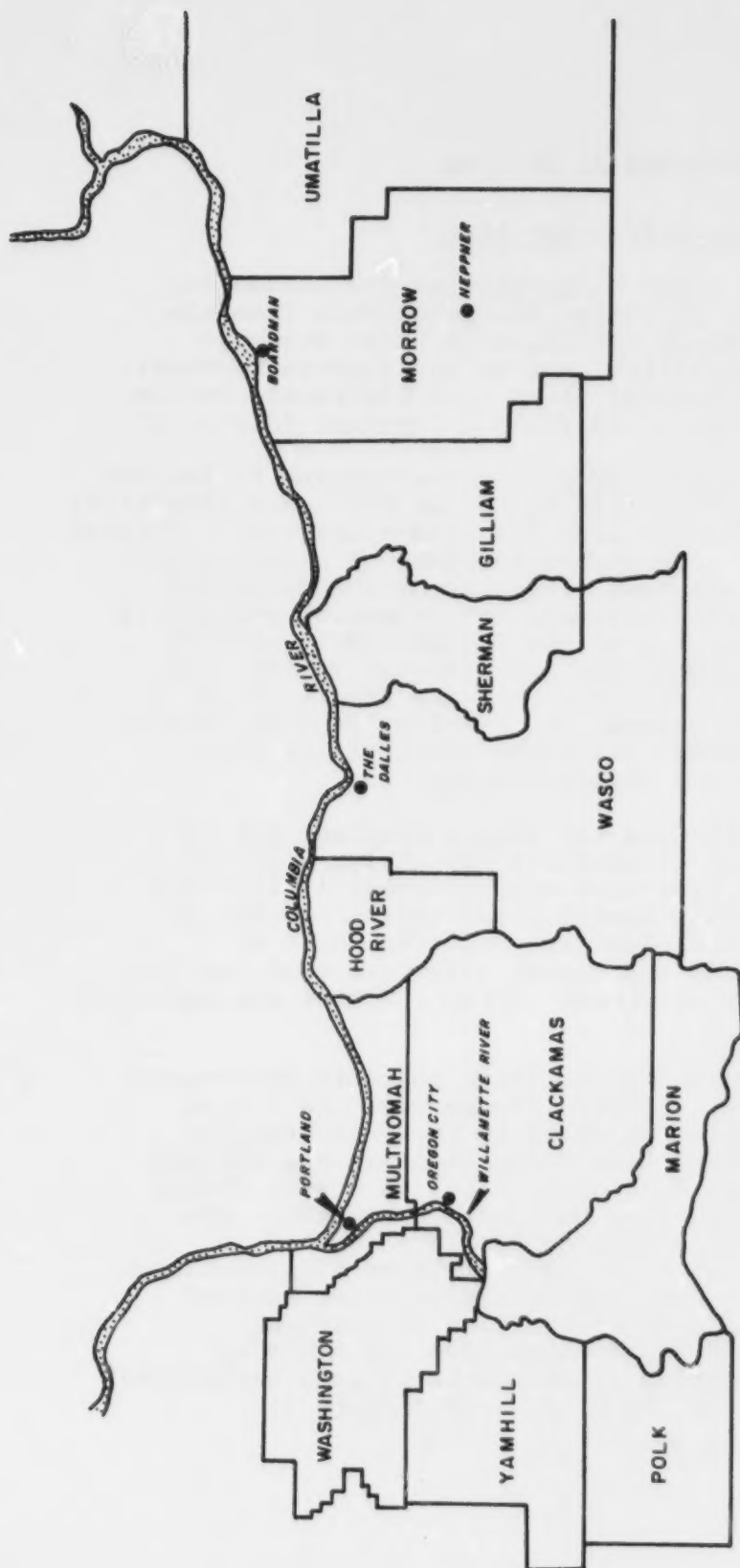


FIGURE 1
PORTLAND SLUDGE DISPOSAL
PROJECT STUDY
AREA

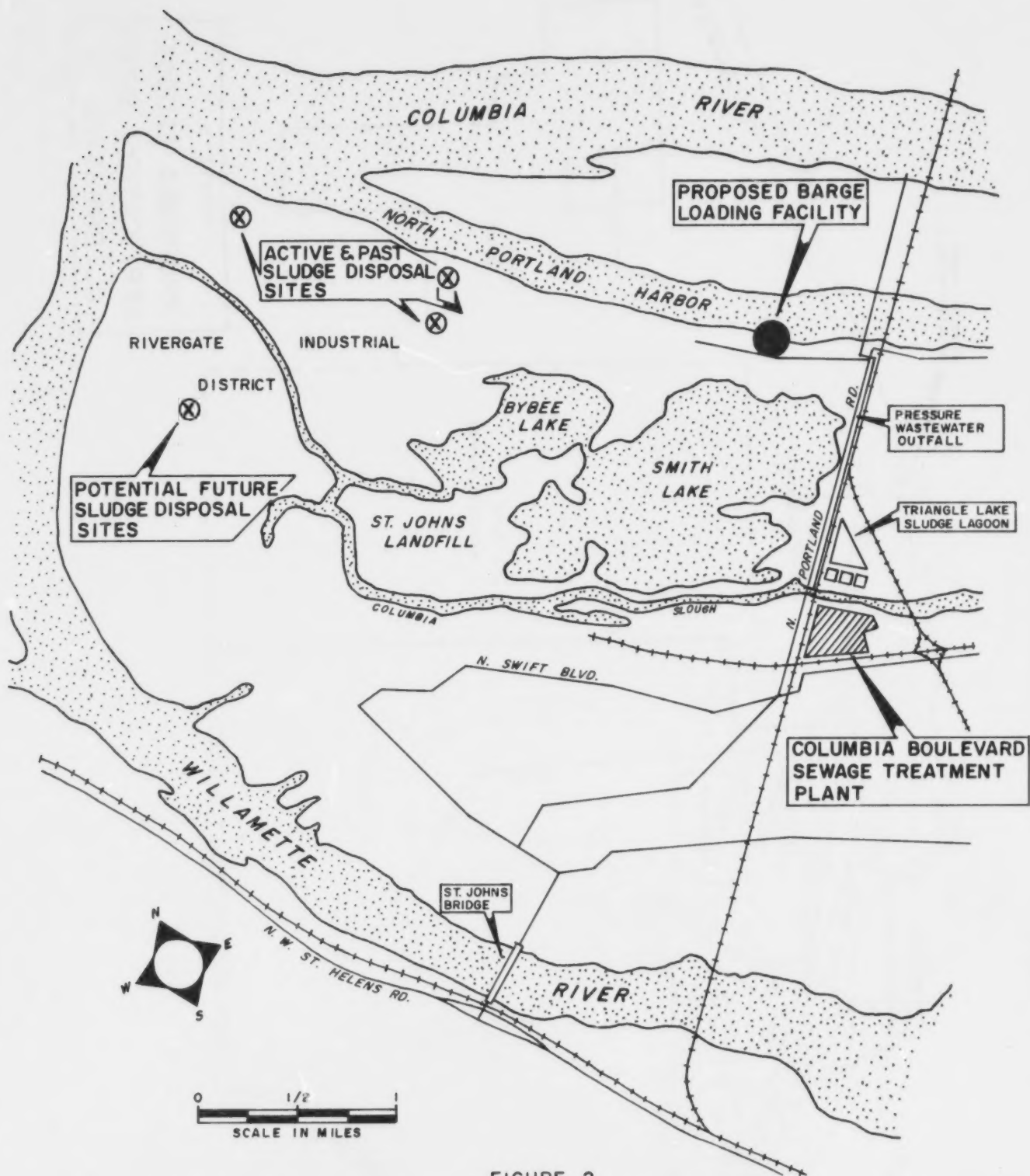


FIGURE 2
**COLUMBIA BOULEVARD PLANT, PROPOSED BARGE DOCK
 & RIVERGATE SLUDGE DISPOSAL SITES**
 (NO-ACTION ALTERNATIVE)

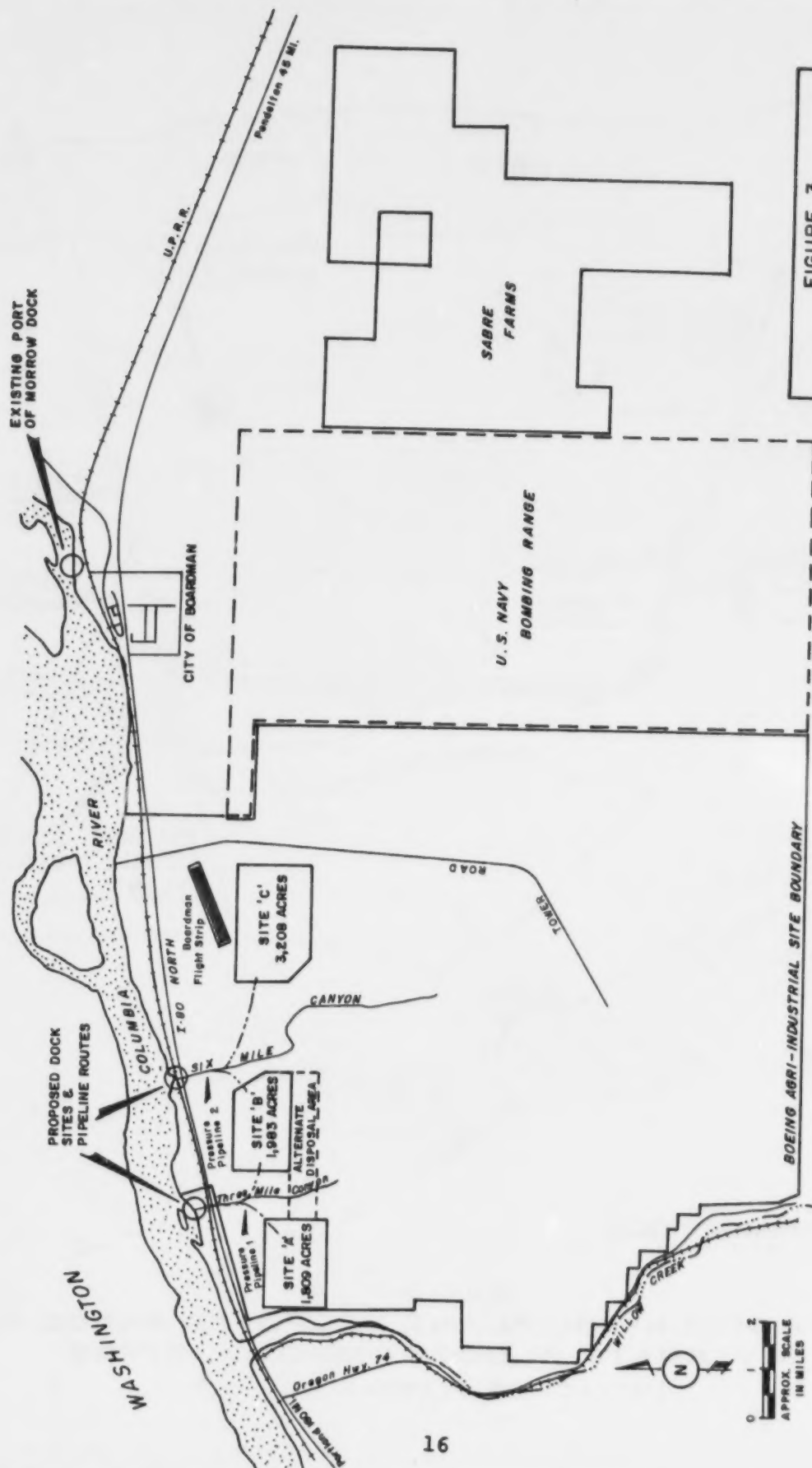


FIGURE 3
PROPOSED SLUDGE
APPLICATION SITES
ALTERNATIVE 'A'

Under Alternative D (land application for soil improvement in the northern Willamette Valley) sludge would be applied to an undetermined acreage of agricultural land within an area of approximately 470 square miles east and south of Oregon City in Clackamas and Marion Counties (Figure 4). One hundred square miles of this study area highlighted in Figure 4 was designated by CRAG as a potential sludge application area for sewage treatment plants in Clackamas County. The remaining 370 square miles was chosen by CRAG as a potential application site for sludge from Portland's Columbia Boulevard sewage treatment plant. Sludge would either be trucked to the North Willamette Valley area or barged from the proposed loading facility on Oregon Slough to an unloading facility on the Willamette River between Oregon City and Canby.

Dry solids produced in Alternative C are amenable to disposal within the total area. The marketing study activity should identify the viability of disposal options for B.E.S.T. or Carver-Greenfield process sludge. These options could include commercial nurseries, farms, recreation areas and home use in and near Portland or be extended into the Willamette Valley or northcentral Oregon.

The organizational format for the present and future environmental setting components relating to the above alternatives is general to site-specific for the Portland area, northcentral Oregon and North Willamette Valley.

Topography

Portland

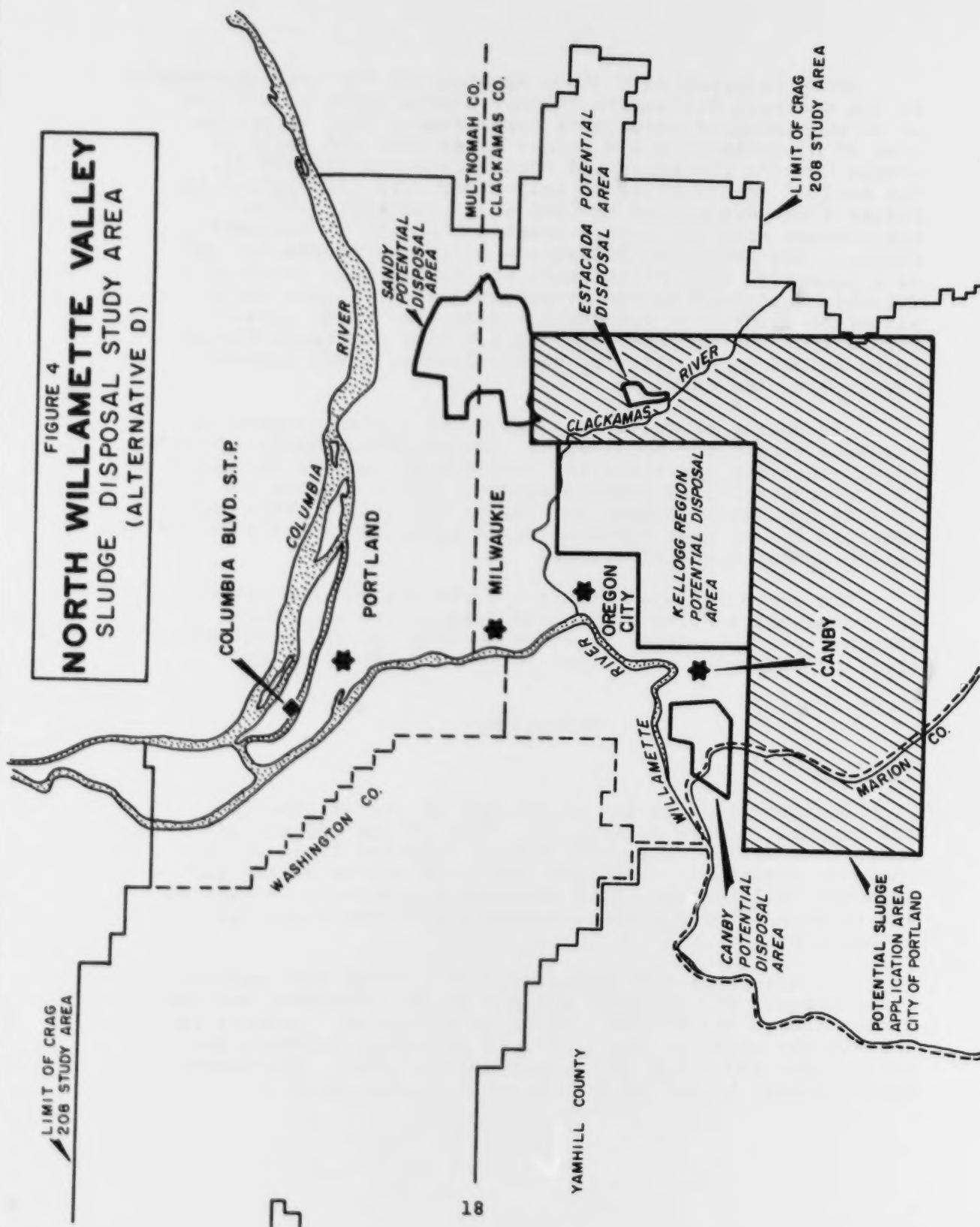
Portland lies at the confluence of the Willamette and Columbia Rivers (Figure 1). Much of the industrial-commercial area of the city lies on alluvial lands while the main residential-business districts are on upland and adjacent hill terrain. The wastewater treatment facilities and existing sludge disposal areas are in the historical floodplain.

The Rivergate Industrial area is a broad flat peninsula lying between the Willamette River on the southwest and the Oregon Slough and Columbia River to the north. Several lakes and sloughs occur on the peninsula including Columbia and Mud Sloughs and Smith, Bybee and Ramsey Lakes. Elevations range between 10 and 30 feet above mean sea level.

LIMIT OF CRAG
208 STUDY AREA

FIGURE 4

NORTH WILLAMETTE VALLEY SLUDGE DISPOSAL STUDY AREA (ALTERNATIVE D)



Northcentral Oregon

The northcentral Oregon portion of the study area lies in the Deschutes-Umatilla plateau, which is bounded by the Columbia River to the north, the Ochoco and Blue mountains to the south and east respectively, and the Cascade Range to the west.

The plateau region slopes gently to the northwest toward the Columbia River. The land is generally smooth and rolling with elevations ranging from 150 feet at the Columbia River to 2,000 feet farther inland. Drainage patterns are characterized by steep swales and narrow canyons with abrupt sides.

Tentative disposal sites in northern Morrow County lie south of the Columbia River in gently sloping topography (Figure 3). The Willow Creek drainage is located approximately 1/2 mile west of Site A. Threemile Canyon lies between Site A and B rising from an elevation of 250 feet at the Columbia River to 450 feet. Sixmile Canyon is located between Site B and C and rises from the river to an elevation of approximately 550 feet at Site C.

Topography of the U. S. Navy Bombing Range and Sabre Farms is similar to that of the Boeing property. Progressing from north to south on the Bombing Range, the terrain changes from gentle undulations to steeply sloping hills. Elevations range from 400 feet to 950 feet. Juniper and Well Springs Canyons extend through the site from south to north. Sabre Farms is dominated by gently sloping terrain. Finley Buttes and Sand Hollow lie on the southern border of the property. Elevations range between 600 and 900 feet.

North Willamette Valley

The Clackamas-Marion County site is characterized by areas of rolling topography and low hills interspersed with relatively level valley bottoms. West of the Molalla River, the valley is gently rolling to level with elevations ranging between 80 and 200 feet above MSL. East and north of the Molalla River the terrain consists of gently rolling terraces at elevations between 200 and 450 feet above MSL with moderate to steeply sloping foothills to elevations exceeding 1,500 feet above MSL. Numerous intermittent and ephemeral drainage-ways dissect the site.

Climate

Northcentral Area

The climate of northcentral Oregon is temperate and semiarid, being characterized by low annual precipitation, low winter temperatures and high summer temperatures. Strong winds, generally from the west and southwest, may occur at any time of the year, causing drifting snows in winter, soil movement and accelerated evaporation in other seasons (U. S. Department of Agriculture, 1961 and 1962). Annual data on climatic conditions in the area can be obtained from the U. S. Department of Commerce.

Climate of the northern Morrow County sites is typical of the region. The site is characterized by a relatively mild average annual temperature of 53.3°F. Temperature extremes average approximately 103°F in July and range from 5°F to 18°F in January. There are an average of 181 days between the first fall and last spring freeze, with freezing temperatures occurring sporadically from October to April (U. S. Department of Commerce, 1974-76).

Total annual precipitation averages 7 to 8 inches with 72 percent occurring from November to April. Extreme amounts of precipitation can occur in the site area. A one-day rainfall total exceeding 2 inches and a monthly maximum snowfall of 31 inches were recorded at Arlington, which is 15 miles west of the site. The evapotranspiration rate averages somewhat less than 30 inches in most years.

Winds commonly from the southwest average 9 mph in the site area with gusts ranging up to 40 mph (Portland General Electric Company, 1973).

North Willamette Valley Area

The north Willamette Valley has a temperate maritime climate with dry, moderately warm summers and wet, mild winters. Varying topography of the valley produces considerable variation in climate. Prevailing winds are from the west and northwest during the summer months and from the south and southwest during the winter storm period. Wind velocities are generally moderate, although strong gusty winds occasionally accompany winter storms.

Climate at the potential Multnomah, Clackamas and Marion Counties sludge disposal sites is similar and typical of the Willamette Valley, with mild temperatures and moderate precipitation prevailing.

Both sites are characterized by a mild average annual temperature of approximately 53.8°F. Temperature extremes for the Rivergate Industrial site vary from a high of 95°F in July to lows ranging from 15°F to 25°F in January. The number of days between the first fall and last spring freeze average 258, with freezing temperatures occurring irregularly between November and March. Temperature extremes for the North Willamette Valley sites average 96°F in July and range from 12 to 23°F in January. There is an average of 224 days between the first fall and last spring freeze, with freezing temperatures occurring sporadically between October and April. The average annual snowfall in the Portland area is about 5 inches (U.S.D.A., 1962 and 1963). Total annual precipitation averages approximately 40 inches and over for both sites, with 88 percent occurring between October and May.

Prevailing winds are generally from the northwest in summer and south in winter for both sites. Occasional windstorms from the Columbia River Gorge occur year-round. Except in localized areas, wind speeds for both sites are generally light with an average annual wind speed of 7.7 mph (Multnomah County Planning Commission, 1977).

Geology

The Rivergate Industrial District in Portland is underlain by Miocene Columbia River Basalt. The Troutdale formation of middle Pliocene age covers the basalt down to 1,500 feet. This formation consists of beds of micaceous and quartzose sandstone and siltstone and tuffaceous siltstone, sandstone and conglomerate. Overlying the Troutdale formation is an alluvial formation of Pleistocene age consisting of unconsolidated sand, gravel, silt, clay and pyroclastic debris. More detailed information on the geology of this area can be found in U. S. Department of Agriculture (1963).

Disposal sites in northern Morrow County are underlain by Columbia River Basalt. Resting over the basalt are coarse-textured Plio-Pleistocene glacial deposits. These deposits consist of clean sand and fine gravel with some large boulders and local silt lenses. Columbia River Basalt is exposed at various locations. Hogenson (1964) gives more detailed geologic information for this region.

The Clackamas-Marion County site is underlain by Eocene sedimentary and volcanic rocks. Resting over Eocene rocks north of the Oregon City area is Columbia River Basalt. Miocene basaltic breccia, tuffs and flows rest over Eocene rocks south of Oregon City and are exposed on the southeastern

edge of the site. Lying over Columbia River Basalt and Miocene tuffs and flows over much of the site is the Troutdale formation. Boring lavas overlies the Troutdale and cap many hills in the northern portion of the site. Alluvial deposits known as Willamette silts overlies the Troutdale formation throughout much of the site. More detailed information on the geology of this region can be found in U. S. Department of Agriculture (1962 and 1963).

Soils

Soils of the Rivergate Industrial District site are derived from recent alluvial sands and gravels. The most common soil series is the Pilchuck urban complex comprised mainly of Pilchuck sand derived from dredge spoil material. Slopes range from 0 to 3 percent. All land application sites in the Rivergate Industrial areas occur on this soil type. Triangle Lake is situated on soils of the Sauvie-Rafton urban complex. Soils range from silty clay loam to silt loam with slopes of 0 to 3 percent. Table 1 describes the properties of these soils in greater detail. Additional information can be found in U. S. Department of Agriculture (1963).

A variety of soils derived from transported materials occur on the Morrow County Sites A through C. Table 1 lists properties of the most common soils (U. S. Department of Agriculture, 1961 and 1962).

Soils of Site A belong primarily to the Prosser and Taunton series. These soil textures consist of silty loam and fine sandy loam, with slopes ranging from 0 to 12 percent, although slopes commonly do not exceed 5 percent. Koehler loamy fine sand with slopes between 2 and 5 percent also occurs on Site A in a limited area.

The major soil series of Site B are comprised of Prosser and Taunton, with slopes ranging from 0 to 20 percent. A large acreage component of Site B is a Prosser-Rock outcrop complex with shallow soils, scattered exposed basalt, and slopes up to 20 percent. A variety of additional soil types occur on Site B. These are Quincy loamy fine sand, Koehler loamy fine sand, and Warden very fine sandy loam. Slopes range from 5 to 20 percent. Average cation exchange capacity is 11 meq/100g.

Common soils of Site C are Quincy and Koehler loamy fine sand with slopes from 2 to 20 percent, although slopes do not typically exceed 5 percent. Other soils occurring in limited areas include Prosser silt loam, Hezel loamy fine sand and dune land. Slopes are usually less than 5 percent. The average cation exchange capacity is 13 meq/100g for Prosser and Hezel soils and is estimated to be less than 5 meq/100g for dune land.

Table 1

PROPERTIES OF COMMON SOILS OCCURRING ON LAND CURRENTLY
UTILIZED OR PROPOSED FOR APPLICATION OF SEWAGE SLUDGE

Soil Series	Study Area Location	Texture Profile	Depth From Surface (in.)	pH	Slope (%)	Organic Matter Content (%)	Cation Exchange Capacity (meq/100g)	Conductivity (umhos/cm)	Depth to High Water Table (ft.)	Depth to Hardpan/Bedrock (in.)	Permeability	Runoff	Water	Wind	Flooding
Prosser	Morrow County	Silt Loam	0-4	6.6-7.3	0-20	(5-1.0) ¹	(15-16)	<1.0	>6.0	20-40	Moderate	Slow to Medium	Moderate	Severe	None
		Silt Loam	4-29	6.6-7.3											
Taunton	Morrow County	Fine Sandy Loam	0-5	6.6-9.0	0-12	(5-1.0)	(12-15)	<1.0	>6.0	20-40	Moderately Rapid	Slow to Medium	Slight	Severe	None
		Fine Sandy Loam	5-15	6.6-9.0											
		v. Fine Sandy Loam	15-22	6.6-9.0											
Kochler	Morrow County	Loamy Fine Sand	0-3	7.4-8.4	0-12	(.5)	(8-10)	<1.0	>6.0	20-40	Rapid	Slow	Slight	Severe	None
		Loamy Fine Sand	3-24	7.4-8.4											
Quincy	Morrow County	Loamy Fine Sand	0-6	6.6-8.4	2-20	<.5	8-9	<1.0	>6.0	>60	Rapid	Slow	Slight	Severe	None
		Loamy Fine Sand	6-61	6.6-8.4											
Pilchuck	Multnomah County	Sand, Loamy Sand	0-12	6.1-7.3	0-3	<.5	(.10)	- ²	>6.0	>60	Very Rapid	Slow	High	Moderate	None
		Sand, Loamy Sand	12-60	6.1-7.3											
Sauvie	Multnomah County	Silty Clay Loam	0-15	5.5-6.5	0-3	2-4	(30-40)	-	>6.0	>60	Moderately Slow	Slow	Slight	Slight	None
		Silty Clay Loam	15-39	5.5-6.5											
		Sandy to Silt Loam	39-60	6.0-6.5											
Rafton	Multnomah County	Silt Loam	0-9	5.6-6.0	0-3	1-3	(20-25)	-	0.0-1.0	>60	Moderate	Slow	Slight	Slight	None
		Silt Loam	9-40	5.6-6.5											
		Silty Clay Loam	40-60	5.6-6.5											
Jory	Clackamas County	Silty Clay Loam	0-6	4.5-6.0	2-12	5-8	22-30	-	>6.0	>60	Moderately Slow	Slow to Medium	Moderate	Moderate	None
		Silty Clay	6-16	4.5-6.0											
		Clay	16-60	4.5-6.0											
Alora	Clackamas County	Silt Loam	0-8	5.6-6.0	0-8	2-3	15-20	-	1.0-2.0	>60	Moderately Slow	Slow	Slight	Slight	None
		Silt Loam	8-46	5.6-6.0											
		Silt Loam	46-65	5.6-6.0											
Woodburn	Marion County	Silt Loam	0-17	5.6-6.5	0-20	3-6	15-25	-	2.0-3.0	>60	Moderate	Slow to Rapid	Slight	Slight	None
		Clay Loam	17-32	5.6-6.5											
		Silt Loam	32-68	5.6-6.5											

¹ Parentheses indicate estimation

² No data available

Source: U. S. Department of Agriculture (1972 and 1976); A. Moss, pers. comm. (1978)

Numerous soil series also occur on Sabre Farms property. The most common soils are Quincy loamy fine sand, Royal fine sandy loam, Sagehill fine sandy loam and Irrigon fine sandy loam. Slopes range from 2 to 5 percent. Additional soils of limited distribution include Gravden gravelly loam, Warden very fine sandy loam, Ellum fine sandy loam, Burbanks loamy fine sand, and Taunton fine sandy loam. Slopes range from 0 to 20 percent.

A variety of soil series occur on the U. S. Navy Bombing Range. The two most common series are Quincy and Koehler loamy fine sand with slopes ranging from 2 to 5 percent. Other soil series on the range include Royal loamy fine sand and silt loam, Sagehill fine sandy loam, Warden very fine sandy loam and sandy loam, and Hezel loamy fine sand. Slopes range from 2 to 20 percent. Active dunes occur throughout the property with greatest concentrations occurring along the northern and southeastern boundaries.

A great variety of soil associations and series derived from alluvial and loess deposits occur on the Clackamas-Marion County site. The Jory series is the most widespread type. It is silty clay loam and silty loam in texture and ranges from 0 to 12 percent in slope. The Aloha silt loam series with slopes of 0 to 8 percent is common west of the Molalla River in Clackamas County. In Marion County the Woodburn-Amity-Willamette association consisting of silt loam over silty clay loam on slopes ranging from 0 to 12 percent is most common. Table 1 describes properties of some of the above soil series in greater detail. Less common soil associations on the site are McBee-Chehalis-Cloquato, Wapato-Cove, Latourell, Briedwell, Woodburn-Willamette, Bornstedt, Concord-Clackamas-Amity, Concord-Dayton-Amity, Jory-Saum, Estacada, and Honeygrove-Apt-McCully. Overall slopes may range from 0 to 50 percent. Cation exchange capacity averages 24 meq/100g. More general and specific information on soils of this region can be found in U. S. Department of Agriculture (1962 and 1963) and U. S. D. A. Soil Conservation Service (1972).

Surface Water Quantity/Quality

Surface water resources of the Rivergate Industrial District are the Columbia River, Willamette River, Oregon and Columbia Sloughs and Smith and Bybee Lakes. Water temperatures and average daily flows for the Columbia and Willamette Rivers in this area are similar to those reported for the river at Portland (U. S. Geological Survey, 1975). Average daily flows in Oregon Slough are influenced by both the Columbia River and by tidal action. Average flows in Oregon Slough range from about 10 to 17 percent of the Columbia River flow (Stevens, Thompson and Runyan, Inc., 1973) or from 20,100 to 34,170 cfs (Stevens, Thompson and Runyan, Inc. 1973). Flows as low as 4,600 cfs could occur in Oregon Slough.

Water quality of Oregon Slough is similar to that of the Columbia River. Biochemical oxygen demand (BOD) ranges between 1.0 and 2.8 mg/l (STR, Inc., 1973).

Major surface water resources in northcentral Oregon are the Columbia, Deschutes, John Day, and Umatilla Rivers. Other intermittent streams of importance include Willow, Butter and Rock Creeks.

Surface water resources of the northern Morrow County sites are limited to the Columbia River. Threemile and Sixmile Canyons on the Boeing property and Juniper Canyon, Well Springs Canyon and Sand Hollow to the east are ephemeral drainages, conveying surface waters only during and shortly after periods of heavy precipitation.

At Sixmile Canyon, the Columbia River has a drainage area of approximately 219,000 square miles. The average daily discharge at this point is approximately 186,000 cfs. The 10-year low flow of the Columbia River in the vicinity of Sixmile Canyon is approximately 47,000 cfs (Portland General Electric Company, 1973).

Columbia River water generally complies with Oregon Department of Environmental Quality water quality standards for dissolved oxygen, turbidity, pH, temperature, coliform bacteria, and certain chemical ions (Oregon Department of Environmental Quality, 1975). Water temperatures range from 32°F in winter to above 70°F in summer. Seasonally high turbidity from land runoff occurs annually.

Major surface water resources of the northern Willamette Valley are the Columbia River and the Willamette River and its major tributaries; the Yamhill, Tualatin, Pudding, Molalla and Clackamas River (USGS, 1975 and 1977).

The entire Willamette River basin has a watershed of approximately 11,500 square miles. The river between Salem and Portland is comprised of three distinctive reaches. These are the upstream reach between Salem and Newberg, which is shallow and characterized by a meandering channel; the Newberg pool from Newberg to Willamette Falls at Oregon City, which is deep and slow-moving; and the tidal reach from Willamette Falls to the river mouth, which is also deep and slow-moving and affected by tides and backwater from the Columbia River during spring and early summer (Rickert, et al., 1977).

Water temperatures in the river range from 32°F in winter to 73°F in July and August. Average summer temperatures at Newberg and Portland are 68°F and 71°F, respectively.

The Willamette River meets most DEQ water quality standards throughout the year (DEQ, 1977). Dissolved oxygen levels have fallen short of standards on several occasions. Coliform bacteria concentrations, resulting primarily from diffuse land sources and regrowth on certain organic industrial effluents, commonly exceed DEQ standards. Temperature increases resulting from solar heating during periods of low-flow are common.

Major surface water resources of the Clackamas-Marion County site are the Clackamas, Molalla and Pudding Rivers. Numerous intermittent and ephemeral drainageways occur throughout the site.

In the Clackamas River, all DEQ water quality standards are met annually. Temperatures in the Molalla and Pudding Rivers normally exceed standards during the summer months. Coliform bacteria counts are often high in the Pudding River from land runoff (Oregon Department of Environmental Quality, 1975).

Groundwater Quantity/Quality

Groundwater supplies of the Rivergate Industrial District sites are derived from alluvial deposits of the Columbia and Willamette River floodplains and lie at depths greater than 6 feet. Water quality information from 3 wells located southeast of John Fulton Terminal Number 6 is given in Table 2. These wells are located within an active sludge disposal site.

In northcentral Oregon Columbia River Basalt, the most productive and widespread aquifer, is at depths up to 700 feet below the surface. Porosity of basalt, however, is low with the percentage of space within lava flows available for water storage averaging less than 1 to 3 percent (Bartholomew, et al., 1973). Additional information on groundwater of this region can be found in Hogenson (1964) and Robison (1971).

Groundwater from basalt aquifers in the region is suitable for most uses. In general, the water varies from soft to moderately hard, has a moderate mineral content, and does not contain significant amounts of objectionable constituents.

The main groundwater body underlying possible disposal sites in northern Morrow County is confined within Columbia River Basalt at a depth of roughly 200 feet. Limited amounts of groundwater are also present in glacial sediments overlying the basalt at depths between 30 to 160 feet and in alluvial deposits of all canyons (Hogenson, 1964).

Table 2

REPRESENTATIVE GROUNDWATER QUALITY OF TEST WELLS LOCATED
AT ACTIVE SLUDGE DISPOSAL SITES (November 12, 1975)

Well Number	Temperature °C	pH	Alkalinity mg/l CaCO ₃	Total Coliform/ 100 ml	Fecal Coliform/ 100 ml	mg/l					
						Cd	Cr	Cu	Ni	Pb	Zn
102	13.0	7.2	250	<10	<4	<.04	<.13	<.04	<.13	<.5	45
103	13.5	7.1	670	<10	<4	<.04	<.13	<.04	<.13	<.5	62
104	13.5	7.1	390	<10	<4	<.04	<.13	<.04	<.13	<.5	25

SOURCE: City of Portland, Bureau of Waste Water Treatment

Significant recharge to groundwater in glacial or alluvial deposits occurs primarily from percolation of irrigation water. Very little recharge reaches these deposits from precipitation. Recharge to basalt aquifers underlying the sites is very limited.

One active well with a static water level approximately 250 feet below the ground surface occurs on Sabre Farms property (Fritz, pers. comm.). Several springs which feed into Juniper and Well Springs Canyons occur on the southern boundary of the U. S. Navy Bombing Range.

Groundwater in the site area is moderately hard, has a predominance of calcium sodium bicarbonate, an average pH of 8.0 and an odor of hydrogen sulfide. Table 3 gives water quality information for five test wells in the vicinity of the site areas. No active wells occur on Sites A through C on the Boeing property or the U. S. Navy site.

The most productive groundwater bodies underlying the Clackamas-Marion County site are alluvial gravels under the Willamette River floodplain and Columbia River Basalt underlying rolling terrace and foothill areas. Groundwater from alluvial aquifers west of the Molalla River is normally perched in many soil types from 0.5 to 3.0 feet below the surface between November and May. Groundwater derived from basalt aquifers lies at depths greater than 6 feet below the soil surface during the entire year. A random sample of 28 wells located within the site area drilled after 1970 had an average static water level of 77 feet below the ground surface with a range of 2 to 312 feet (Oregon Water Resources Department, Well Water Reports). According to Hampton (1972) the average depth to the water table within the site area south of Aurora and Mulino is 30 feet.

The quality of groundwater within the foothills and valleys of the site is typical of the Willamette Valley with soft to moderate hardness and low concentrations of chloride, sulfate and nitrate. Iron content can be excessively high in some areas. Table 4 gives information on chemical quality of groundwater from 7 wells within the site area taken from Hampton (1972).

Flood Hazards

The Rivergate Industrial District sites are subjected to flooding hazards primarily from the Columbia River in June during the peak runoff from snowmelt upstream. The U. S. Army Corps of Engineers 100-year flood elevation on Columbia Slough is estimated to be 28 feet above mean sea level (City of Portland, 1977). Management of upstream impoundments on the Columbia River substantially reduces the possibility of major floods in this area.

Table 3
QUALITY OF GROUNDWATER FROM TWO WELLS
IN THE VICINITY OF MORROW COUNTY DISPOSAL SITE

Location (a)	Thickness of basalt penetrated by well (feet)	Date Sampled (b)	Temperature (°F)	Silica (SiO ₂)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO ₃) + Carbonate (CO ₃)	Sulfate (SO ₄)	Chloride (Cl)	Fluoride (F)	Dissolved Solids	Hardness of CaCO ₃	Sodium-Adsorption Ratio (SAR)	Specific Conductance (micromhos at 25°C)	pH
3N 23E-25bc	756	5-09-67	-	61	3.0	0.6	106	15	213	0.4	53	2.0	347	10	14	501	8.4
4N 24E-22acc	86	5-09-67	62	50	30	20	64	4.5	58	50	26	0.8	372	154	2.2	588	8.0
3N/26E-5cbd	830	5-11-67	74	78	9.0	2.9	57	12	176	0.2	20	1.5	268	34	4.2	344	8.1
3N/26E-10cca	494	5-11-67	74	79	9.4	3.1	56	10	168	2.0	20	1.6	264	36	4.0	329	8.0
3N/26E-10dcc	4	5-11-67	64	55	40	11	25	46	143	48	26	0.4	280	145	0.9	416	7.5

a Township/Range - Section
b From Robison (1971)

Table 4

CHEMICAL ANALYSES OF GROUNDWATER FROM THE CLACKAMAS-MARION COUNTY SITE

Location	Depth of Water- bearing zone(s) (feet)	Date of Collection	Temper- ature	Milligrams per liter														Dissolved solids				Hardness		Sodium-adsorption- ratio (SAR)	Specific conductance (micromhos at 25°C)	pH
				Silica (SiO ₂)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO ₃)	Carbonate (CO ₂)	Sulfate (SO ₄)	Chloride (Cl)	Fluoride (F)	Nitrate (NO ₃)	Phosphate (PO ₄)	Boron (B)	Calculated	Residue on evaporation at 180°C	As CaCO ₃	Noncarbonate	Percent Na				
T48R1W	126-129	6-6-62	13	55	42	2.2	31	10	7.6	2.5	164	0	1.2	2.8	0.1	0.2	1.5	0.00	180	--	120	0	16	0.3	260	7.5
T48R1E	285-293	6-11-62	14	57	48	.50	20	9.0	25	2.4	166	0	.0	6.5	.0	.2	1.2	.02	195	193	87	0	46	1.2	273	7.3
T48R2E	115-122	6-11-62	13	55	25	1.2	4.0	3.0	5.1	.4	40	0	.0	2.0	.0	.1	.01	.03	61	62	22	0	42	.5	72	6.5
T48R3E	113	6-6-62	12	54	29	.01	7.0	3.5	4.0	.4	47	0	.8	1.0	.0	.9	.05	.00	70	-	32	0	28	.3	84	6.6
T58R1E	325-340	7-26-62	16	60	43	1.1	30	7.5	33	4.0	130	0	3.2	50	.3	.0	.11	.11	238	-	106	0	47	1.4	376	7.8
T55R1E	436-438	2-14-57	-	-	12	.01	2,310	.0	1,410	3.2	13	18	6,190	.0	-	-	-	-	9,950	-	5,760	5,750	38	8.1	16,700	7.1
T58R2E	105-138	6-6-62	11	52	43	.30	11	6.4	8.1	.8	83	0	1.6	2.2	.3	.1	.24	.00	115	-	54	0	33	.5	139	7.3

Source: Hampton (1972)

Sites A through C in northern Morrow County are subjected primarily to rapid runoff caused by cloudburst storms in late spring and early summer. Flash floods have occurred in the past in Sixmile Canyon (Norton, pers. comm.). The probably maximum flood in the Columbia River as computed by the U. S. Army Corps of Engineers (1969) would reach an elevation of 268 feet in the John Day Pool at the Dalles Dam and have a regulated peak flow of 820,000 cfs.

The traditional flood season in the northern Willamette Valley is from November to April with more than two-thirds of recorded floods occurring from December to February. Flash floods in the Willamette River and its tributaries have been the most common type in the past, occurring approximately every 4 to 5 years. Small streams can flood several times a year (USDA, 1963). Control structures on the Willamette River and several tributaries have reduced potential flood hazards.

Streams of the valley containing flood hazard reaches are the Tualatin, Pudding, Molalla, Yamhill, Clackamas and Willamette Rivers (Battelle, 1973). The Willamette River and its tributaries below Oregon City are also affected by the Columbia River at flood stage in early June.

Flooding in the Clackamas-Marion County site could potentially occur in the Molalla, Pudding and Clackamas Rivers drainages.

Aesthetic Values

The vast semiarid country of northcentral Oregon is bounded by the John Day Pool of the Columbia River to the north and by the Blue Mountain range far to the south. Parts of the gently rolling hills of native sagebrush have been converted to grain land which provides the major visual diversity in the region. Perennial streams typically flow through deeply scoured canyons lined with rocky bluffs, of which the Columbia River in Sherman and Gilliam Counties is a good example. Pockets of riparian vegetation in these drainageways provide islands of native greenery in a predominately arid environment.

The northern Willamette Valley is bounded by the Coast Range to the west and Cascades to the east and encompasses the major metropolitan areas of Portland and Salem. The riverine habitat of the Columbia and Willamette Rivers and their tributaries, surrounded by rolling hills and valleys interspersed with agricultural land and native vegetation, provide a diverse scenic environment. Mount Hood to the east and Mount St. Helens to the north are the major visual attractions in the Portland area.

Air Quality

Air quality in the Portland Rivergate Industrial area and Clackamas County is generally representative of the Portland area. Relatively light average winds in the basin, particularly during September and October, result in a high potential for air stagnation and thus air pollution problems through low-level temperature inversions. Suspended particulate matter, carbon monoxide and photochemical oxidants derived primarily from automobile and industrial sources are the pollutants of main concern. Specific areas of the basin wherein air quality standards are exceeded vary in noncompliance with wind speed and direction.

Northcentral Oregon lies within the Department of Environmental Quality (DEQ) central and eastern air quality control regions. Air quality within the northern portion of these control regions is generally acceptable, with few pollutants exceeding air quality standards set by the DEQ. Of the pollutants monitored suspended particulate matter exceeded DEQ air standards 3 days in the Pendleton area in 1976. Naturally entrained dust was the primary cause of standards violations (Department of Environmental Quality, 1976).

Vegetation

Common plant species of the Rivergate Industrial site along Oregon Slough and surrounding Smith and Bybee Lakes are riparian dominants such as black cottonwood, Oregon ash and willows. Dominant understory species include blackberry, snowberry and reed-canary grass. Common forbs are cocklebur and teasel. Approximately 2 acres of riparian vegetation occurs on the proposed barge loading facility site. The remainder of the vegetation is dominated by weedy composites and grasses. Common plant species occurring on the proposed pipeline route are Oregon ash, blackberry, teasel and weedy grasses and forbs.

Current and proposed disposal sites at the Rivergate area are characterized by sparse stands of weedy, annual grasses and forbs, perennial grasses and willow shrubs.

Northcentral and northeastern Oregon lie within an extensive, arid shrub-grass community known as steppe and shrub-steppe. Less common plant communities include riparian, marsh and conifer forest habitat. Limited riparian, wet meadow and marsh habitat occur in drainageways of intermittent and perennial streams. Forest vegetation is generally confined to mountain slopes of the Blue and Ochoco Mountains.

Large areas of the steppe community have been altered through cultivation of wheat, potatoes and similar crops or by grazing of sheep and cattle. Heavy grazing has resulted in elimination of many native bunchgrasses and has allowed an invasion of the alien grass and forb species.

Acreages of steppe, shrub-steppe and other habitat types occurring in Gilliam, Morrow and Sherman Counties are shown in Table 5. Additional information can be found in Franklin and Dyrness (1973).

Common plant species of the northern Morrow County site are native shrub-steppe vegetation and introduced agricultural species. Site A, on the Boeing property, is dominated by agricultural species of grasses, alfalfa, wheat and introduced weedy species. Sites B and C as well as the pipeline routes up Threemile Canyon and Sixmile Canyon are characterized primarily by native shrub species such as big sagebrush and rabbitbrush. Common grasses are the perennials, needle-and-thread grass and Sandberg bluegrass and the annuals, cheatgrass and slender fescue. Dominant weedy species include Russian thistle and filaree. The proposed dock unloading facilities at the bases of Threemile and Sixmile Canyons are generally rocky-gravelly surfaces supporting sparse vegetation.

The dominant plant community of the U. S. Navy Bombing Range is native shrub-steppe vegetation. The target area of the bombing range, because it has been relatively undisturbed, contains many examples of native grasses and forbs which are fast disappearing elsewhere. Sabre Farms is dominated by introduced agricultural species such as potatoes, wheat, alfalfa and grasses.

Major plant communities occurring in the northern Willamette Valley are oak woodland, conifer forest, grassland and riparian habitat. Much of the valley has been subjected to extensive human influences in the form of cities, farmland and other developments. Wherever natural vegetation remains, it has been altered by human uses such as grazing and logging.

Acreages of major plant communities in the northern Willamette Valley for Clackamas, Marion, Multnomah, Polk, Washington and Yamhill Counties are shown in Table 5. See Franklin and Dyrness (1973) for additional information.

Native vegetation of the Clackamas-Marion County site is typical of the Willamette Valley region. The dominant native plant communities of the site are coniferous forests, characterized by Douglas fir and bigleaf maple and riparian stands of black cottonwood, Oregon ash, and willow species. A large proportion of the site is characterized by agricultural crops such as hay, fruits, nuts, vegetables, berries and grains. Introduced weedy species of grasses and forbs are common throughout the rural-agricultural and residential areas of the site.

Table 5

ACREAGES OF MAJOR PLANT COMMUNITIES AND
OTHER LAND USES IN THE STUDY AREA, 1970

<u>Habitat Type</u>	<u>Acreage</u>			
	<u>North Willamette Valley</u>	<u>% of total</u>	<u>Northcentral/Eastern Oregon</u>	<u>% of total</u>
Riparian-Marsh	41,506	1.15	5,169	.20
Grassland	290	.01	706,335	27.01
Shrub-Steppe	-	-	741,922	28.37
Oak Woodland	66,814	1.86	-	-
Conifer Forest	2,210,611	61.40	228,890	8.75
Agricultural	1,060,513	29.46	931,384	35.62
Urban-Industrial	204,013	5.67	1,153	.04
Other	16,364	.45	119	.01
TOTAL	3,600,111	100.0	2,614,972	100.0

SOURCE: Oregon State Department of Fish and Wildlife, unpublished preliminary data

The proposed dock unloading facility between Oregon City and Canby is characterized by riparian species of willow, black cottonwood, Oregon ash, blackberry and conifers, e.g., Douglas fir.

Rare and Endangered Plant Species

Several rare and endangered plant species are known to occur in northcentral Oregon and the northern Willamette Valley (Siddall, pers. comm.). Most species are commonly found along roadways, fence rows and in remnants of undisturbed native plant communities. Land utilized for agricultural purposes, either cropland or grazing land, typically supports few, if any, native species because of the persistent disturbance to soils and vegetation. The potential for existence of additional species presently uncataloged or new sites of cataloged species is high for undisturbed habitats in both regions.

Fisheries Resources

A total of 45 or more species of fish inhabit the Columbia and Willamette Rivers. Appendix B lists those species commonly present. Nine anadromous species utilize both river systems. Those species of major importance as commercial and recreational resources upstream of Portland, are chinook and coho salmon, steelhead, American shad, smelt and white sturgeon. Salmonid species utilize the main stems of the Willamette and Columbia Rivers primarily for upstream migrations to spawning sites in tributary streams, for the rearing of juvenile fish and for the downstream migration of juveniles (smelts) to the ocean. Fall chinook salmon, winter steelhead and chum are known to spawn occasionally in the main stems of both rivers. American shad and smelt utilize the main channels of the Willamette and Columbia Rivers for spawning. Appendix B gives general life history information for anadromous species of the region.

Many species of game and nongame fishes are residents in the Columbia and Willamette Rivers. For most species spawning and rearing of juveniles occurs mainly in backwaters or tributaries of both rivers. Species that utilize the main channel and connecting sloughs for spawning include channel catfish, smallmouth bass, walleye and white sturgeon.

Rare, Endangered or Threatened Species

No rare, endangered or threatened species of fish are known to occur within the Columbia or Willamette River systems.

Wildlife Resources

Few areas of undisturbed native vegetation occur in the Rivergate Industrial District. Riparian and wetland habitat of Smith and Bybee Lakes probably support the greatest diversity of wildlife species in the peninsular area. Remnants of riparian habitat on the barge loading facility site and pipeline route are commonly inhabited by nesting bird species such as the bewick's wren, rufous-sided towhee and song sparrow and wintering species such as the dark-eyed junco. Mammals such as the striped skunk and raccoon probably occur in limited numbers. Reptiles, e.g., the red-spotted garter snake, and amphibians, e.g., the Pacific treefrog, may also occur here in moist depressions.

Little wildlife usage was noted on sites of sewage disposal because of the general lack of vegetation and cover.

The shrub-steppe community of northcentral Oregon supports relatively few wildlife species due to unfavorable climatic conditions and the resulting low diversity and productivity of vegetation. Irrigated agricultural land has replaced native vegetation in many areas thereby increasing habitat diversity and to some degree wildlife habitat opportunities. Additional wildlife species normally not found in shrub-steppe habitat occur here, particularly where agricultural land lies in close proximity to the Columbia River. Common wildlife species and their preferred habitat types of northcentral Oregon are given in Appendix B.

Field inspection of Sites A through C on the Boeing property in northern Morrow County took place in January 1978 when few representative wildlife species were observed. Additional information on species common to the study area can be found in the Portland General Electric study (1973) which was conducted in similar habitat approximately 7 miles to the south.

An island located at the mouth of Threemile Canyon is utilized by Caspian terns and ring-billed gulls for nesting. An estimated 3,000 gulls and 300 terns nested on this island in 1977 (Ward, pers. comm.). This general area is also used in winter by waterfowl for feeding and loafing.

The northern Willamette Valley, because of its greater diversity of plant communities, supports a wider variety of wildlife species than northcentral Oregon. All plant communities of the valley - conifer forests, oak woodland, riparian forests, grassland and agricultural land - provide habitat for many species. Some species may be restricted to one habitat type while other more adaptable species may utilize several habitat types. Common wildlife species and their preferred habitat types in the northern Willamette Valley are given in Appendix B.

Wildlife of the Clackamas and Marion County sites is typical of the region. Those native and introduced species associated with native conifer and riparian stands or agricultural land are most common (see Appendix B). Dominant domestic mammals are cattle, sheep and horses.

Rare, Endangered and Threatened Species and Species of Special Interest

Six rare, endangered or threatened wildlife species and 9 species of special interest occur within the study area, encompassing northcentral and northeastern Oregon and the northern Willamette Valley. Appendix B lists rare, endangered or threatened species and species of special interest, respectively, and their probable distribution within the study area.

No nesting or wintering habitat designated as critical for rare, endangered or threatened species occurs on any sites in Morrow, Multnomah and Clackamas Counties.

Several species of special interest are known or likely to nest within site areas. These include the burrowing owl and long-billed curlew in northern Morrow County. The U. S. Fish and Wildlife Service is currently conducting a long-billed curlew nesting study in eastern Oregon. The U. S. Navy Bombing Range is a major study site. The Washington ground squirrel, which is uncommon in the Columbia plateau region, also occurs on the Navy Bombing Range. The great blue heron, which nests in large colonies, known as rookeries, is found at several locations on the Columbia, Willamette and Clackamas Rivers (Battelle, 1973). One rookery designated as a significant natural area by the Nature Conservancy (1976) is located on the Clackamas River on the northern boundary of the Clackamas-Marion County site.

Land Use

Portland Rivergate District

Present Land Use. Most land in the Rivergate Industrial District is zoned for industrial use. Industries such as Oregon Steel Mills and Collier Carbon and Chemical Corporation are located in Terminal Number 1 on the Willamette River. John Fulton Terminal Number 6 is located on Oregon Slough. Stauffer Chemical Company lies east of the proposed barge loading facility. Smith and Bybee Lakes and Kelley Point Park are the major recreational - open space areas on Port of Portland property. The St. Johns Sanitary Landfill, which serves most of Multnomah County, is located in the southern portion of the Rivergate Industrial District. The landfill is estimated to reach fill capacity about 1980 (Multnomah County Planning Commission, 1977).

All sites currently utilized or proposed for sludge disposal or transportation are zoned industrial. Disposal sites currently used or proposed for use lie on Port of Portland property. The proposed barge loading facility site is located on private property. The proposed pipeline route runs parallel to the Union Pacific-Burlington Northern Railroad right-of-way and across private industrial land. The barge loading facility site and acreage proposed for sludge disposal are currently idle.

Major routes into the disposal site area are North Columbia Boulevard and North Portland Road leading to Port of Portland Terminal Number 6 and North Rivergate Boulevard and North Lombard Street to Terminals Number 1 through 5. Access to the proposed barge loading facility is via Suttle Road.

Proposed Land Use. Port of Portland land currently utilized or proposed for sludge disposal is planned primarily for industrial use by the Port or will be leased or sold to private industries. Some recreational and commercial development in the vicinity of Smith and Bybee Lakes and Columbia Slough is planned by the Port (Jonasson, pers. comm.).

Northcentral Oregon

Present Land Use. The primary use of land in northcentral Oregon is agricultural. In 1974 over 2,326,000 acres (89 percent) of land in Gilliam, Morrow and Sherman Counties were in farms and ranches. Average farm or ranch size ranged from 2,400 to 4,400 acres (U. S. Department of Commerce, 1977).

Over 1,000,000 acres are plowed for cropland in this region. The most important crop is dry-farmed wheat. Other crops of importance are potatoes and hay (Morrow County) and other grains. The annual market value of all crops in 1974 was in excess of \$67,000,000 (U. S. Department of Commerce, 1977).

Approximately 1,270,000 acres of the region are utilized as rangeland for grazing cattle and sheep. The market value of livestock and their products was over \$11,000,000 in 1974 (U. S. Department of Commerce, 1977).

The remaining land of the region is dominated by urban and industrial uses. Major rural centers are Heppner and Boardman in Morrow County, Arlington and Condon in Gilliam County and Moro in Sherman County. Industrial developments occur primarily along the Columbia River. The major industry is food processing.

Recreational-open space land occurs primarily in the southeast corner of Morrow County in the Umatilla National Forest, east of Boardman in Umatilla National Wildlife Refuge, Dyer Wayside and J. S. Burres State Park in Gilliam County.

Major routes of transportation of the region are Interstate 80 North connecting the Portland metropolitan area to northcentral and northeastern Oregon, U. S. Highway 97 in Sherman County, State Highway 19 in Gilliam County, and State Highway 74 in Morrow County.

Proposed sludge application Sites A, B, and C in northern Morrow County lie within a 100,000-acre agricultural-industrial park owned by the State of Oregon and leased to the Boeing Agricultural Company (Figure 5). Approximately 10 miles southeast of the site, Portland General Electric Company is constructing a coal-burning power plant and filling the 5,000-acre Carty Reservoir. Bordering Boeing Company land on the west is the U. S. Navy Weapons System Training Facility. The southern end of this facility is utilized for practice in approach and deployment of simulated weapons, while the northern portion is currently leased for pasture.

Sites A and B, which are zoned agricultural by the county, are part of a 34,800-acre farm subleased by Sim-Tag Farms primarily for the production of potatoes. Potatoes are currently grown in rotation with wheat on approximately 22,800 acres. The use of sewage sludge for growing root crops (i.e., potatoes) is unacceptable according to DEQ guidelines. Less important crops are alfalfa and pasture grasses. Approximately 4,000 acres of alfalfa are grown in rotation with wheat. Grasses for livestock grazing are grown on 655 acres on a 3- to 4-year rotational basis with alfalfa and wheat. Remaining acreage is utilized as rangeland, feedlots, storage warehouses, or is idle (Martin, pers. comm.).

Water supplies for irrigation are drawn from the Willow Creek arm of the Columbia River. Crops are irrigated by elevated circular irrigation systems.

Virtually all of Site A is under agricultural use. Crops currently grown are primarily alfalfa and pasture grasses with approximately 350 acres of wheat.

Approximately 130 acres on Site B are currently utilized for growing alfalfa. The remainder of the site is characterized by native vegetation on undulating shallow rocky soil unsuitable for agricultural use. Cattle and sheep grazing occurs on this land.

Site C is dominated by native shrub-steppe vegetation and is part of a 15,000-acre sublease for grazing cattle and sheep in winter and spring. This site is also zoned agricultural by the county.

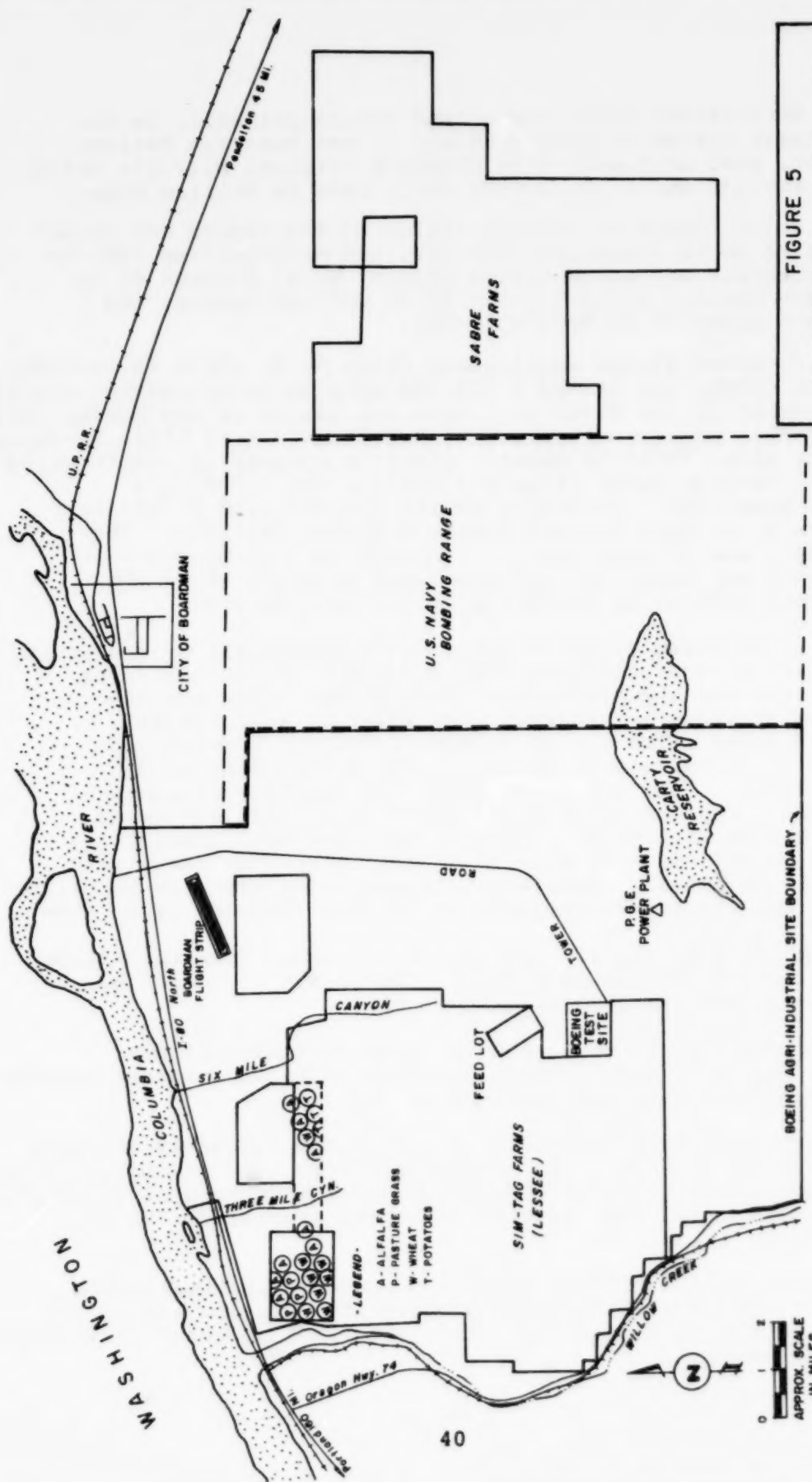


FIGURE 5
EXISTING LAND USE
MORROW COUNTY SLUDGE
APPLICATION SITES
ALTERNATIVE 'A'

Land in Threemile and Sixmile Canyon lies, for the most part, on Boeing Company property and is utilized for grazing of cattle and sheep south of I-80N. Canyon land north of I-80N is idle. The base of Threemile Canyon south of I-80N is U. S. Army Corps of Engineers property. The railroad spur line for the Portland General Electric Company coal-burning power plant extends across Sixmile Canyon in Section 30.

Routes of access to Sites A, B and C are Threemile Canyon Road between Sites A and B and Tower Road east of Site C.

The U. S. Navy Bombing Range (46,720 acres) is currently used by Navy aircraft for practice in approach and deployment of simulated weapons. A large portion of the training facility is also leased for grazing. At the present time there are no definite plans for any change in use of the bombing range (Rappel, pers. comm.).

Sabre Farms property (16,000 acres) is currently utilized for the production of wheat, potatoes, alfalfa and pasture grasses for cattle. Wheat in rotation with potatoes is grown on approximately 8,900 acres; alfalfa, spring wheat, and grazing pasture is grown on 3,125, 1,375 and 5,000 acres, respectively (Fritz, pers. comm.). Crops are irrigated primarily with water from the Columbia River using pivoting sprinkler systems.

Proposed Land Use. No plans exist for changes in land use of Sites A and B under the Sim-Tag sublease. Site C, which is currently under a grazing lease, is planned for agricultural use in the near future because the soils are highly suitable for crops such as potatoes and wheat (Norton, pers. comm.).

It is anticipated that Sabre Farms will also continue to maintain its present agriculturally-oriented land use.

North Willamette Valley

Present Land Use. Over 2,000,000 acres (61 percent) of land in the northern Willamette Valley in Clackamas, Marion, Multnomah, Polk, Washington and Yamhill Counties are forested. Approximately one-half the forests in the region are owned by the state or federal government, a portion of which is available for recreational-open space use.

Approximately 1,000,000 acres (30 percent) of the region are agricultural land. Average farm size in 1974 ranged from 72 to 195 acres (U. S. Department of Commerce, 1977). Seventy percent of farm land in the valley is utilized for crop production, of which wheat and hay are most common. The annual market value of crops in the valley was over \$155,000,000 in 1974.

Present land use of the Clackamas-Marion County site is predominantly timber production and open space to the southeast and suburban-rural agricultural uses with land holdings of 2 acres or greater over the remainder of the site (Figure 6). Agricultural land in farms of 20 acres or more extends across the northeast corner and southwest half of the site. Average farm size in 1974 was 72 acres in Clackamas County and 118 acres in Marion County (U. S. Department of Commerce, 1977).

Small agricultural landholdings in suburban and some rural-agricultural areas are used as grazing land for small numbers of cattle, horses and sheep. Areas of more intensive agricultural uses in Clackamas County produce mainly hay, seed crops and grain. In Marion County, a variety of crops are grown within the site area including vegetables, tree fruits and nuts, berries, hops, grass, legume and sugar beet seed, hay, grain and nursery stock. Some acreage is also used for livestock and dairying.

Within Clackamas County approximately 20 percent of the site, predominantly in the southeast corner is zoned for timber growing and harvesting with a minimum lot size of 20 or 40 acres. Seventeen percent of the site lying south of Canby is zoned for exclusive farm use with a minimum lot size of 20 acres. Approximately 12 percent associated with rural centers is zoned for general use (single-family dwelling, commercial) with minimum lot sizes of 1 acre or less. Eight percent is zoned rural-agricultural with lots ranging from a 1- to 5-acre minimum. The remaining 43 percent of the site within Clackamas County is currently unzoned (Clackamas County Planning Department, 1978 zoning map).

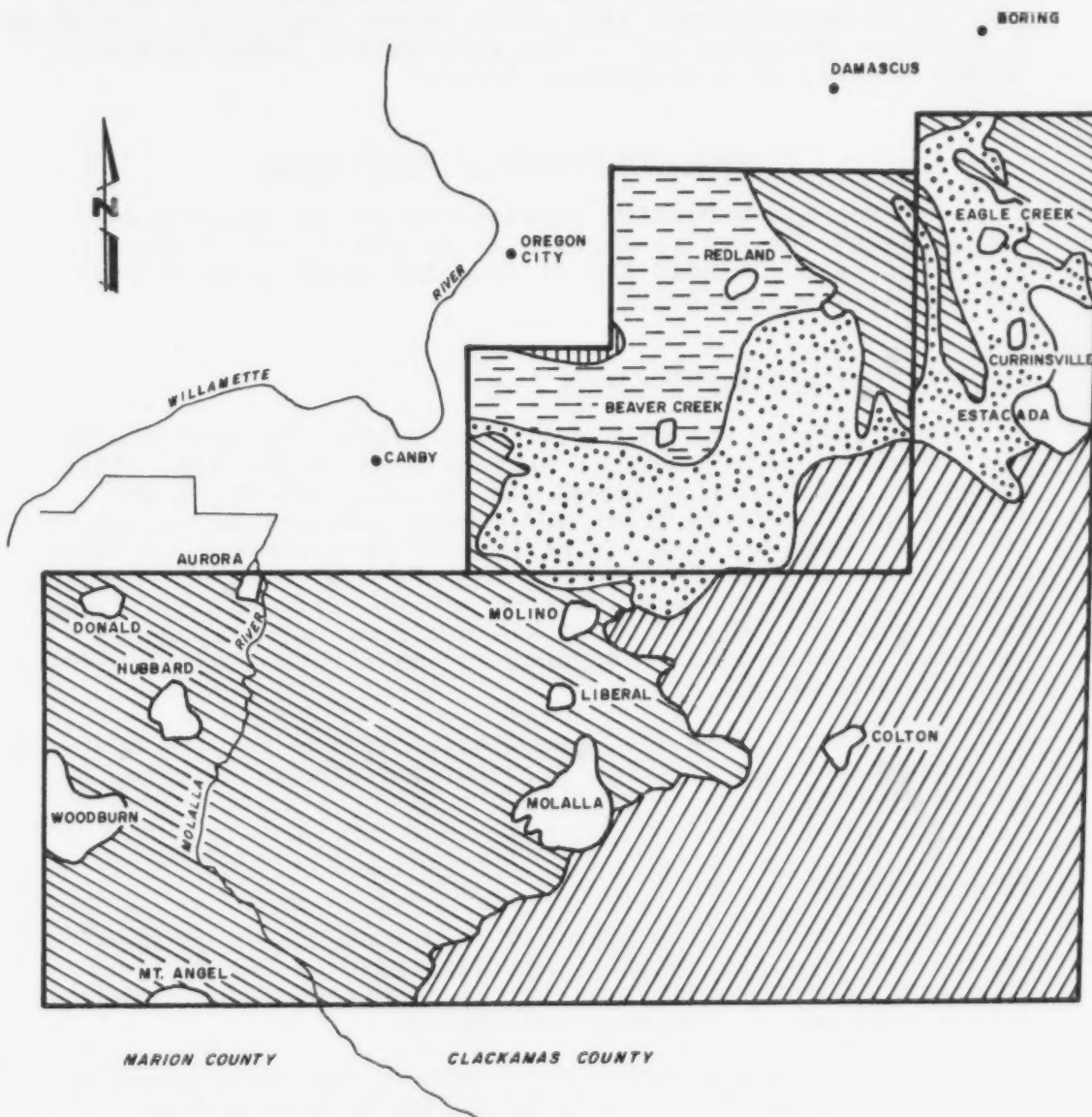
The majority of land in Marion County within the site is zoned for exclusive farm use. Within rural centers land is zoned residential-agricultural with a minimum lot size between 6,000 square feet and 1 acre. Surrounding rural centers, limited acreage is zoned for farm use with a minimum lot size of 20 acres (Marion County Planning Department, pers. comm.).

Major routes of transportation into the site area are Interstate 5, State Highway 99E, 211, 213 and 224.

Proposed Land Use. Land use trends on the Clackamas-Marion County site most likely reflect overall county trends. In Clackamas County the population has increased approximately 4 percent annually, resulting primarily in reductions of agricultural land. Acreages of land in farms have decreased from 210,000 acres in 1969 to approximately 174,300 acres in 1974, which represents a 17 percent decrease in 5 years (Clackamas County Planning Department, 1974). In Marion County

FIGURE 6

GENERAL LAND USE AREAS CLACKAMAS & MARION COUNTY SITE



-LEGEND-

	SUBURBAN/RURAL CENTERS		SUBURBAN - 5 ACRES
	URBAN - OREGON CITY		RURAL 5-20 ACRES
	AGRICULTURAL - 20 ACRES		FOREST - 20 ACRES

43

SOURCE: CLACKAMAS COUNTY PLANNING DEPARTMENT, 1974
MID WILLAMETTE VALLEY COUNCIL OF GOVERNMENTS, 1972

acreages of land in farms has also decreased in recent years. In 1964 a total of 333,624 acres of county land was in farms. In 1974 this total dropped to 295,285 (U. S. Department of Commerce, 1977). This represents an annual decrease of 1.2 percent in agricultural land while county population increased 2.5 percent annually during the same period (Mid Willamette Valley Council of Governments, 1972).

Present and Projected Populations

Present and projected populations of the study area are important in two respects: 1) as the contributing source of sewage sludge and 2) from the standpoint of project impacts on residents.

City of Portland Service Area

According to the CRAG 208 Study (1977) the 1975 population of the City of Portland service area is 450,595. This estimated population includes the Columbia Boulevard STP (CBSTP) and the Tryon Creek STP (which contributes sludge to the CBSTP) (see Table 6). The City of Portland service area encompasses an area larger than the official City of Portland boundaries. Other areas included are the City of Lake Oswego, portions of the City of Milwaukie and some unincorporated portions of Multnomah, Clackamas and Washington Counties (City of Portland, 1976).

The future (year 2000) population of the service district is projected to be 505,471, a 12 percent increase during a 25-year period.

Morrow County

Morrow County is a sparsely populated county of approximately 5,200 people located 160 miles east of the City of Portland. Major communities in the county include Heppner (the county seat), Boardman and Irrigon.

In recent years the county has been the focal point of substantial population growth resulting primarily from agricultural expansion and related economic activity. Approximately 50,000 acres in northern Morrow County have come under irrigation in the past few years.

Boardman has experienced substantial growth during the past 5 years. The most recent estimate is 1,100 people in 1976 (Pacific Northwest Regional Commission, 1977), a dramatic increase from the 1970 population of 190.

Table 6

PORTLAND SERVICE DISTRICT 1975 POPULATIONS AND PROJECTIONS OF POPULATION FOR THE YEAR 2000

	1975		2000	
	Total Service Area Population ¹	Estimate of Population Actually Sewered ²	Total Service Area Population ¹	Projected Population Actually Sewered ²
Columbia Boulevard STP	404,986	263,241	437,865	380,943
Tryon Creek STP	45,609	34,663	67,606	58,817
	450,595	297,904	505,471	439,760

¹ Populations taken from Technical Supplement 8 of the CRAG Sludge Management Study. These represent final population estimates and differ from the preliminary estimates presented in the City of Portland's Alternative Methods for the Disposal of Sewage Solids report (Table 1, page 16).

² The estimates of the population actually sewered within the Portland Service District are from Nunamaker (pers. comm.). A portion of the unsewered population contributes sludge from septic tank pumpage.

Table 7 depicts the present and projected growth of Morrow County and Boardman based on several scenarios of growth developed by the East Central Association of Counties (ECOAC, 1977).

The City of Boardman is approximately 3 1/2 miles northeast of the three possible sites for sewage disposal.

Clackamas County

The proposed North Willamette sludge application area encompasses approximately 400 square miles. The nearest major population centers are Oregon City with a 1975 population of 12,460, West Linn with a population of 8,800 and Gladstone with a population of 8,120.

According to the CRAG 208 Study, the 1975 population of the sludge application area was approximately 14,000. Population projections for the year 2000 estimate a 110 percent increase from the 1975 population to 29,400.

Laws, Rules, Policies and Institutional Practices

A checklist of governmental agencies and departments having regulatory authority and/or planning responsibility affecting the planning implementation and operation of a sludge disposal project by the City of Portland follows.

U. S. Environmental Protection Agency

The Environmental Protection Agency (EPA) is charged with administering the Federal Water Pollution Control Act (PL 92-500), the Federal Clean Air Act and the Federal Safe Drinking Water Act. Under terms in the Water Pollution Control Act, EPA was required to prepare and enforce minimum water quality standards for the nation. The 1972 amendments to this act established the National Pollution Discharge Elimination System, which allows EPA to require a permit for any discharge of waste materials to a waterway.

Table 7

PRESENT AND PROJECTED POPULATIONS - MORROW COUNTY AND CITY OF BOARDMAN

	Scenario ¹	1970 ²	1975 ²	1976 ³	1980 ⁴	2000 ⁴
Morrow County	A	4,470	5,190	-	7,290	10,590
	B	-	-	-	9,910	11,590
	C	-	-	-	-	13,300
Boardman	A	190	700	1,100	1,280	2,370
	B	-	-	-	2,620	2,900
	C	-	-	-	-	3,410

¹ Scenarios A-C established by East Central Oregon Association of Counties (ECOAC).

See Appendix D for assumptions made by ECOAC in their population projections.

² U. S. and Oregon census.

³ Population estimate from Pacific Northwest Regional Commission (1977).

⁴ ECOAC projections.

To comply with the 1972 Water Pollution Control Act timetable, all treatment plants discharging to surface waters were to meet the federal secondary treatment effluent requirements by July 1, 1977 (listed in Federal Register, Vol. 40, No. 159, August 15, 1975 - see Table N-5). Portland is in compliance with the secondary treatment requirement. By July 1, 1983, all municipal treatment facilities must have instituted "Best Practicable Waste Treatment Technology". By July 1, 1985, municipal treatment facilities must have reached a condition of no discharge of pollutants. In this definition, complete elimination of discharge is not implied; only elimination of discharge of pollutants, where a pollutant is defined as anything that adversely affects the quality of water necessary to support a beneficial use.

The act was recently amended (December 1977) and EPA is in the process of preparing regulations.

Under Section 208 of the Federal Water Pollution Control Act, EPA is also responsible for approving plans and programs to control "non-point" source pollution. The state must identify regions with "substantial water quality control problems" and authorize a single organization to operate "a continuing areawide waste treatment management planning process". The Columbia Region Association of Governments (CRAG) recently conducted an "Areawide Waste Treatment Management Study" to satisfy the 208 planning requirements of the Federal Water Pollution Control Act. This plan is presently under review by EPA.

To achieve the goals of PL 92-500 EPA participates in the funding (75 percent) of the Clean Water Grant program which enables wastewater system improvement projects. This funding system is operated jointly with the state; the DEQ has been given responsibility in administration of the program. This EIS is a required element in the application for Clean Water Grant funds by the City of Portland.

In administering the Federal Clean Air Act, EPA has established National Ambient Air Quality Standards. These standards are designed to protect human health from the effects of chronic air pollution. Any project that creates local air pollution conditions in excess of NAAQS may have federal funding withheld.

The Federal Safe Drinking Water Act of 1974 required EPA to set standards for drinking water quality and to establish guidelines for state regulation and enforcement of these standards. It also gave EPA the responsibility of protecting underground sources of drinking water. Protection will probably be implemented by requiring permits for injection of wastes

into usable aquifers and by prohibiting waste disposal operations that will endanger the quality of drinking water sources. National interim primary drinking water regulations were recently released by EPA (Federal Register - Vol. 40, No. 248 - Wednesday, December 24, 1975). Any option of land disposal of wastewater or sludge adopted as part of this proposed sludge disposal project will be analyzed by EPA for its effects on local drinking water supplies.

In November 1977, the EPA issued a technical bulletin concerned with the environmental factors associated with municipal sludge management (42 CFR, No. 211, November 2, 1977). The bulletin addresses factors important to the environmental acceptability of particular sludge management options. Acceptable methods of sludge utilization and disposal are presented, emphasizing the return of sludges to the environment in an ecologically acceptable manner. These sludge management guidelines are presented in Appendix A of this EIS.

In the November 1977 technical bulletin the EPA stated that the establishment of allowable levels for heavy metals and other contaminants in sludges applied to the land (specifically agricultural land) are planned to be developed and published under the Solid Waste Disposal Act as amended by the Resource Conservation and Recovery Act of 1976 (PL 94-580). Until such time, EPA considers the report Application of Sewage Sludge to Cropland: Appraisal of Potential Hazards of the Heavy Metals to Plant and Animals prepared by the Council for Agricultural Science and Technology (EPA 430/9-76-013; November 1976), to represent the most current information available on the potential effects on agricultural crops and animals by heavy metals in sewage sludges applied to cropland. Table 8 illustrates current recommendations for the agricultural land disposal of heavy metals contained in sewage sludge.

Public Law 94-580 amending the Solid Waste Disposal Act was passed in October 1976 giving EPA broad authority in the regulation of solid waste disposal. Major emphasis is placed on the design and operation of sanitary landfills; the law also includes grants to states to develop solid waste management plans, a federal ban on open dumping and resource recovery encouragement. On May 12, 1977, the EPA Office of Solid Waste produced a working draft of proposed regulations. Sludge is identified as solid waste with the notation that 7.3 million tons are produced in the United States each year; this represents a potential threat to public health.

Table 8

MAXIMUM CUMULATIVE SLUDGE
METAL APPLICATION LIMITS

Metal	Soil cation exchange capacity (milliequivalents per 100g)		
	0-5	5-15	>15
	Amount of Metal (kilograms per hectare)		
Zinc	250	500	1,000
Copper	125	250	500
Nickel	50	100	200
Cadmium	5	10	20
Lead	500	1,000	2,000

Source: 42 CFR, No. 211; November 2, 1977
U.S.D.A., October 1976

The EPA Office of Solid Waste has been placed under the jurisdiction of the Assistant Administrator for Water and Hazardous Materials for coordination with the clean water grant program of PL 92-500 to give a unified regulatory program within EPA. EPA has identified two sludge management task forces to (1) develop an overall agency strategy for municipal sludge and (2) to prepare guidelines for land disposal of sludge as required in Section 1008 of the Resource Conservation and Recovery Act. The results of this latter task are expressed as the technical bulletin on municipal sludge management (42 CFR No. 211) as previously described.

On February 6, 1978, the EPA published Proposed Classification Criteria dealing with solid waste disposal facilities (43 CFR No. 25, February 6, 1978). These proposed regulations contain minimum criteria for determining which solid waste land disposal facilities shall be classified as posing no reasonable probability of adverse effects on health or the environment. These proposed criteria are important in that they relate also to municipal sewage sludge, specifically when applied to land used for the production of food chain crops. Criteria were proposed dealing with cadmium limitations in crop production (43 CFR, No. 25, February 6, 1978).

U. S. Food and Drug Administration

The U. S. Food and Drug Administration (FDA) is responsible for promulgating recommended acceptable levels of various contaminants in human and animal foods.

The FDA recently responded to the EPA's draft technical bulletin on municipal sludge management (41 CFR, No. 108; June 3, 1976) by stating that the limitations for sludge usage to protect the public health were not adequately addressed. The FDA supports the cadmium and lead limitations shown in Table 8 and further recommends that sludges containing over 20 ppm (mg/kg) cadmium and/or 1,000 ppm (mg/kg) lead not be used on agricultural land and crops.

U. S. Advisory Council on Historic Preservation

The Advisory Council is responsible for ensuring that the procedures for protecting historic and cultural properties are fulfilled under the National Historic Preservation Act of 1966. The Council reviews federal, federally assisted and federally licensed undertakings affecting cultural resources (36 CFR Part 800).

U. S. Army Corps of Engineers

The Corps of Engineers has jurisdiction over uses of all navigable waterways in the United States. The construction of any structure (i.e., barge loading and unloading docks) will require Corps permit approval.

U. S. Coast Guard

The conveyance of sludge by barge will have to be in conformance with U. S. Coast Guard regulations for the commercial shipping of hazardous materials.

Oregon Department of Environmental Quality

In September 1977, the DEQ issued proposed regulations and guidelines regarding the "handling, disposal and use of municipal sludge relating to land application". These regulations prescribe the manner in which sewage sludge can be transported, disposed of or used beneficially for agricultural purposes.

The DEQ regulates the disposal of sewage sludge through NPDES and state permits. All disposal sites, sludge handling and support facilities and disposal operations must be approved by the Department.

ALTERNATIVE SLUDGE HANDLING SYSTEMS

Introduction

The United States Environmental Protection Agency (EPA) promulgated regulations outlining minimum requirements comparing project alternatives in the preparation of an EIS (Federal Register of April 14, 1975, CFR 40, Part 6). The comparative evaluation should include an analysis of the environmental impacts, commitments of resources, costs and societal risks associated with each alternative. The reasons why a proposed alternative management system is finally selected must also be explained in detail. This section contains a description of the alternatives considered for this project and evaluations relative to cost and engineering considerations.

This comparative evaluation and alternative selection is accomplished by what the EPA has termed cost-effectiveness analysis. The cost-effectiveness analysis is defined by the EPA as:

"The waste treatment management system determined from the analysis to have the lowest present worth and/or equivalent annual value without overriding adverse nonmonetary costs and to realize at least identical minimum benefits in terms of applicable Federal, State and local standards for effluent quality, water quality, water reuse and/or land and subsurface disposal."

The cost-effectiveness analysis therefore incorporates the total project costs, technical and environmental considerations of the alternatives, ability to implement each alternative, public and agency comments on the project, and miscellaneous considerations relative to specific project constraints.

The Facility Plan for which this draft EIS has been prepared is titled Alternative Methods for the Disposal of Sewage Solids. It was developed by the Department of Public Works of the City of Portland. A sludge management study was originally developed for the City of Portland by Stevens, Thompson and Runyan, Inc., Consulting Engineers, and was published in 1972; the study recommended incineration of the sludge followed by landfill of the resulting ash. This recommendation evoked considerable public reaction and a formal hearing was held where written and oral testimony was received. Following the hearing the city made its evaluation and prepared a Facility Plan on alternative sludge management systems in accordance with EPA regulations. The initial study was submitted for review on September 2, 1976 and the final report became available on March 3, 1977.

The existing sludge disposal sites were projected to be at capacity by about 1980. The sludge management study was undertaken to develop a long-term solution for the disposal or reuse of an estimated 90 tons/day of sludge by the year 2000. The eventual solution should provide an economical, reliable, socially acceptable and environmentally sound sludge handling system compatible with both the existing treatment processes at the city's main Columbia Boulevard treatment plant and the recommendations of the Columbia Regional Association of Governments (CRAG) Areawide Waste Treatment Management Study (208 Plan).

The Facility Plan and this draft EIS deal specifically with the handling of the sludge to be generated at the Columbia Boulevard plant. Detailed consideration is not given to the wastewater collection systems nor the existing or proposed treatment systems at the Columbia Boulevard plant. The alternative sludge management systems evaluated include all systems presented in the Facility Plan and additional alternatives that appear to provide similar benefits to the city.

Constraints

In developing alternative sludge handling systems it should be recognized that both regulatory and nonregulatory constraints are imposed upon facility selection. The principal constraints influencing the development of alternatives for the sludge handling and disposal system are:

- 0 PL 92-500 - Federal Water Pollution Control Act Amendments of 1972.
- 0 EPA Cost-Effectiveness Analysis guidelines.
- 0 Oregon State Department of Environmental Quality and the EPA National Pollutant Discharge Elimination Systems (NPDES) Permit.
Federal Register, Vol. 42, No. 211, November 2, 1977.
- 0 EPA Municipal Sludge Management, Federal Register, Vol. 42, No. 211, November 2, 1977.
- 0 Oregon State Department of Environmental Quality, Handling, Disposal and Use of Sewage Sludge.
- 0 U. S. Environmental Protection Agency and Oregon State DEQ, general regulations covering ocean dumping, air pollution emissions and other process-related standards.

- 0 Non-regulatory constraints relating to considerations of time of implementation, energy consumption, operational reliability, existing facilities and committed or ongoing facility construction.

Public Law 92-500, the Federal Water Pollution Control Act Amendments of 1972, gives the EPA the responsibility for establishing waste discharge criteria, both liquid and solid, for all federally-funded wastewater treatment facilities.

The EPA Cost-Effectiveness Analysis Guidelines provide a uniform method for computing the costs of wastewater treatment alternatives. The term "cost-effectiveness analysis" has already been defined as encompassing more than just the dollar value of each candidate alternative. These guidelines delineate the planning period over which the alternatives should be evaluated, the elements of cost that should be included, the interest rate that must be used, guidance on the service life of various types of facilities, and the salvage value that should be used for the proposed projects. They provide a uniform and standardized procedure for comparing the cost of the various project alternatives. Considering that the guidelines do not permit the inclusion of speculative projections of inflation, changing interest rates, etc., the comparative costs for each alternative do not represent the actual "true" cost of a project over the planning period. However, they do approximate the costs and present a uniform method for comparing alternative systems within a project.

The Oregon State Department of Environmental Quality and the EPA must issue an NPDES permit to ensure that the proposed facilities achieve the desired standards for wastewater discharge as well as sludge disposal. Therefore, the NPDES permit establishes specific requirements for the disposal of liquid and solid wastes, which greatly influence methods of treatment and handling. In the formulation of the project alternatives, only those that will meet the NPDES permit requirements are considered feasible.

The federal and state guidelines for municipal sludge management apply principally to the beneficial use or disposal of sewage sludge on the land. The guidelines present allowable loading rates for agricultural uses including crop types. These guidelines place restrictions on land application of sludge, limitations on public access to the site, and amounts of surface runoff, infiltration to groundwater and heavy metal concentrations. The guidelines are therefore related principally to the beneficial use of sludge and the protection of the environment and public health.

The regulations governing the ocean discharge of sewage solids, which were not enforced prior to 1971, basically prohibit the use of the ocean as a disposal means. Ocean disposal simply makes use of the large dilutional capacity of the ocean to dispose of sewage sludge. Through the Marine Protection, Research and Sanctuaries Act and the Water Pollution Control Act Amendments of 1972, the EPA was directed to promulgate regulations governing ocean discharge. Based on these regulations, only those facilities that currently operate an ocean dumping program can operate if they meet regulatory criteria. The Oregon State DEQ and the EPA both do not permit ocean dumping off the Oregon coast line.

Other regulations cover air emission standards that particularly affect incinerations of sludge and other heat treatment systems. Because of the stringent air quality standards required by these regulations, heat treatment processes consume greater amounts of fuel than previously.

The sludge management alternative ultimately selected for Portland should also be compatible with the Columbia Region Associations of Governments, Area-wide Waste Treatment Management Plan. Any proposed sludge handling system that is not compatible with the plan may require amendment of the plan, which would be difficult, time-consuming and costly. Alternatives chosen by the city conform to regional planning expectations.

The nonregulatory constraints include the time for implementation of a system and the direction taken for sludge treatment, i.e., the Phase I project. Implementation and operation of the system by about 1980 assumes importance when it is considered that the existing disposal sites are projected to be at capacity. The committed direction of sludge management relates to existing or soon to be constructed treatment facilities that exclude some potential sludge handling systems, or at least lead to increased costs, that make a particular alternative not cost-effective.

Existing Oregon Programs for Land Application of Sewage Sludge

Since 1972, the City of Salem, Oregon, has applied liquid sewage sludge to farm lands in the vicinity of the Willow Lake STP. These agricultural applications started informally but became a full-scale, regulated disposal program in 1975.

During 1976, the City of Salem spread over 8,250,000 gallons (approximately 1,400 dry tons) of BIOGRO onto agricultural lands within a 7-mile radius of the sewage treatment plant. In 1977 the amount of sludge applied increased to over 22,500,000 gallons (approximately 3,755 dry tons). Annual application rates have approximated 12,000 gallons (2 dry tons) per acre.

Sludge application is dependent upon weather conditions and the weight-supporting conditions of field soils. The use of sludge spreaders with extra-large tires has reduced problems of soil compaction when fields are moist. The best time for sludge application has been when the fields are driest. Sludge generated during the winter months is stored in lagoons at the Willow Lake plant.

Chemical analyses of Willow Lake plant sludge indicate that Salem sludge is relatively high in total nitrogen (6.2 percent) and low in heavy metals; copper - 296 ppm; nickel - 33 ppm; cadmium - 8 ppm; lead - 400 ppm; zinc - 1,300 ppm; and chromium - 60 ppm. The high nitrogen value and low levels of heavy metals make Salem sludge particularly attractive as an agricultural fertilizer.

The agricultural lands on which the BIOGRO is spread are approved for this purpose by the DEQ.

Several other small treatment plants have also applied sludge to agricultural lands in the Willamette Valley. The Oak Lodge STP and Oregon City STP report having favorable results from land application (Norman, Abraham, pers. comm.; Snyder, letter to G. Ward, February 1975). A description of present land application systems in the Portland region is presented in the CRAG Sludge Management Study, Technical Supplement 8, Appendix B.

Description of Alternatives

A total sludge handling system (treatment, conveyance, storage and disposal) can be formed from a variety of individual processes and therefore the final selection of a system must be based on an economic and environmental evaluation of the more viable systems. Selection of these systems will be based upon a consideration of the existing facilities at the Columbia Boulevard plant, the project sludge quantities and the compatibility with the regional plan. This chapter therefore identifies these considerations and describes those alternatives considered and the reasons for screening or eliminating certain of the alternative sludge handling systems.

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The sludge disposal sites now used by the City of Portland are projected to be at capacity by about 1980. Consequently, the handling, treatment and subsequent disposal of these solids represent an immediate problem to the City of Portland. Portland's two wastewater treatment plants currently yield approximately 65 tons of sludge per day and are projected to yield 90 tons of sludge per day by the year 2000.

Existing City of Portland Treatment Facilities

The City of Portland currently owns and operates two wastewater treatment plants which are projected to serve approximately 136 square miles of residentially, commercially and industrially zoned areas. These areas are located within the City of Portland, the City of Lake Oswego and portions of unincorporated areas in Multnomah and Clackamas Counties as well as a small area of the City of Milwaukie. The larger, Columbia Boulevard plant also handles septic and holding tank pumpings from the surrounding tri-county area of Washington, Multnomah and Clackamas and unprocessed sludges from the Tryon and Clackamas Counties, Kellogg Creek plants.

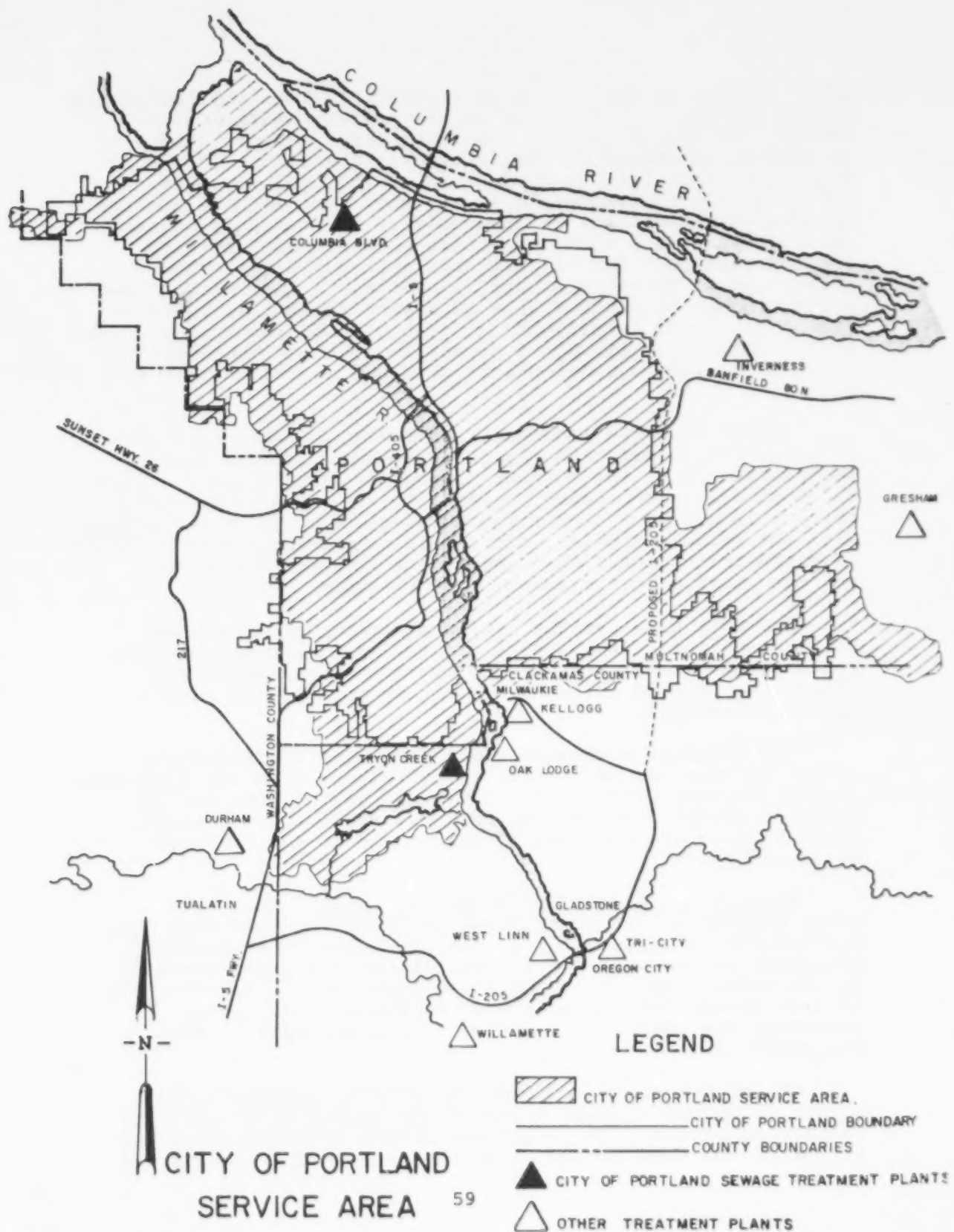
The two city plants process a combined average daily wastewater flow of about 71.5 mgd in the summer and 106 mgd during the winter months. The Columbia Boulevard plant is located close to the Columbia River and about 2 miles west of Interstate 5. The smaller Tryon Creek plant is located adjacent to the Willamette River immediately north of Lake Oswego, and within the corporate limits of the City of Lake Oswego. Both plants and the potential service area for these two plants are shown in Figure 7. The existing treatment facilities are briefly described below.

Columbia Boulevard Wastewater Treatment Plant. The Columbia Boulevard Wastewater Treatment Plant has a design capacity of 100 million gallons per day with a maximum hydraulic flow capacity of 300 million gallons per day. The plant provides secondary treatment. A description of the wastewater treatment process can be found in the facilities plan report.

The clear liquid overflow from final clarification basins is disinfected by the addition of chlorine. The disinfected final effluent then flows to the Columbia River through an outfall sewer.

The solids from the treatment processes are treated differently than the wastewater. The grit and screenings are taken to the sanitary landfill. The primary sludge is dewatered and pumped to gravity sludge thickeners where the

Figure 7



CITY OF PORTLAND
SERVICE AREA

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water content of the sludge is reduced. Water overflowing the sludge thickener is returned to the primary sedimentation basins. Thickened sludge, 7 percent concentration, is collected and pumped to four anaerobic digesters. These digesters stabilize the sludge and at the same time reduce its volume by approximately 40 percent. The methane produced by anaerobic digestion is used to fire boilers that maintain the digesters at a 95°F temperature as well as providing supplemental fuel for boilers that heat buildings. The stabilized or digested sludge is applied to Port of Portland property near Terminal 6 (the Rivergate Industrial District area), as a soil conditioner or is pumped to the Triangle Lake sludge lagoon for storage. Excess liquid from the digestion process, called supernatant, is returned to the primary sedimentation basins.

Sludge from the secondary sedimentation basins is either returned to the aeration basins or pumped to tanks (waste-activated sludge) for further processing and disposal. This waste sludge is thickened by centrifuges and as much as 40 percent is pumped to the anaerobic digesters for stabilization with the primary sludge. The remaining waste-activated sludge is aerobically digested, using two of the aeration basins, and then pumped to the Triangle Lake sludge lagoon.

The city also has the option of combining thickened primary and secondary sludges and heat-treating the mixture. The treated sludge is dewatered by vacuum-filtration and often heat treated before being transported to the city's sanitary landfill.

The Columbia Boulevard plant processes approximately 19,000 gallons per day of undigested sludge from the Clackamas County, Kellogg Creek plant and 17,000 gallons per day of digested sludge from the city's smaller Tryon Creek plant. These sludges are conveyed by tank truck to the Columbia Boulevard plant.

Tryon Creek Wastewater Treatment Plant. The Tryon Creek Wastewater Treatment Plant is being expanded from 5 to 8.3 million gallons per day. The plant provides secondary treatment to the wastewater. Wastewater flows are conveyed in two gravity sewers to the Tryon Creek plant from the City of Lake Oswego and the southwest Portland area. After treatment the chlorinated effluent is discharged to the Willamette River.

The sludge collected from the primary sedimentation basins is pumped through a degritting mechanism to gravity-thickening basins. The thickened sludge withdrawn from the bottom of the tank is pumped to the anaerobic digesters and

the water overflowing the top of the basins is returned to the primary clarifiers. As previously explained the methane produced by the anaerobic digesters is used to maintain the digesters at a constant 95°F. The digested, or stabilized sludge, is hauled by truck to the Columbia Boulevard plant or to the Rivergate Industrial District for incorporation into the soil. The excess liquid (supernatant) from the digesters is returned to the primary clarifiers.

Existing Sludge Disposal

The existing sludge handling systems at both the Columbia Boulevard and Tryon Creek plants have been described. Ultimate use and disposal practices for the sludges generated at these plants have also been briefly identified. This section, however, includes a more detailed analysis.

Current Sludge Production Quantities. The sludge production from the two city-owned treatment plants is reasonably predictable because it is directly related to the characteristics of the raw influent wastewater. The 1975 average daily flow rates for these plants as well as the historically averaged concentrations for the BOD and suspended solids are given in Table 9. Using these values and assumptions about the removal efficiencies of the various treatment processes, an estimate of the sludge quantities can be computed. The computed values can then be checked easily against the measured sludge production. The measured sludge quantities for the two plants for the year 1976 are shown in Table 10, together with the values computed from the influent wastewater characteristics. The digestion process reduces the quantity of sludge to be handled by approximately 40 percent, and therefore the amount of sludge produced for disposal is about 60 percent of the values shown in Table 10.

The computed and measured sludge quantities in Table 10 show close agreement; therefore, the computational procedure is considered suitable for projecting future sludge quantities.

Current Sludge Disposal Methods. Although the City of Portland currently has available three methods for disposing of sewage sludge, all three are considered temporary and are collectively projected to serve the city only to about 1980. Each of the three methods is discussed below.

Sludge Soil Stabilization. This method involves incorporating the stabilized sludge into the soil on vacant, industrial lands in the Rivergate Industrial District. The land is owned by the Port of Portland and is zoned for industrial development. This method has proven to be a successful soil conditioning agent by binding the soils, which then provide the necessary medium for ground cover growth and thus the prevention of wind erosion. The availability

Table 9

AVERAGE WASTEWATER CHARACTERISTICS, 1976

<u>Parameter</u>	<u>Units</u>	<u>Columbia Boulevard Plant</u>	<u>Tryon Creek Plant</u>
Flow	mgd	76.1	4.6
BOD	mg/l	166	175
SS	mg/l	140	154

Table 10

MEASURED AND COMPUTED SLUDGE QUANTITIES FOR 1976

<u>Sludge Type</u>	<u>Units</u>	<u>Columbia Boulevard Plant</u>		<u>Tryon Creek Plant</u>	
		<u>Measured</u>	<u>Computed</u>	<u>Measured</u>	<u>Computed</u>
Screenings	cu ft	75	76	-	5
Primary Sludge	lbs/day	63,100	59,000	-	3,800
Secondary Sludge	lbs/day	<u>39,500</u>	<u>42,500</u>	<u>-</u>	<u>2,800</u>
Total Primary + Secondary	lbs/day	102,600	101,500	8,000	6,600

of this area for continued sludge incorporation is directly dependent upon the rate of industrial growth in the area. At the time of the study immediate growth was projected, but it apparently did not materialize. Since the initial projection revised projections show that the capacity of the area may be reached between 1985 and 1988, based on slower industrial development.

Sludge Lagooning. Under this disposal method most of the digested, waste-activated sludge and part of the primary, digested sludge is pumped to a sludge lagoon. This lagoon, called Triangle Lake, is located immediately north of the Columbia Boulevard plant, close to the Oregon Slough. The detention time in the lagoon is sufficient to allow the solids to settle to the bottom of the lagoon where they undergo additional anaerobic digestion and slowly accumulate. The liquid, or supernatant, then flows through three polishing ponds where the BOD is reduced. The final effluent from these ponds is heavily disinfected with chlorine and discharged to the main outfall sewer for conveyance to the Columbia River.

The sludge lagoon has been operational since 1970 and, due to the accumulation of solids, is now nearing its capacity. On the basis of existing practices, the lagoon system is projected to be full prior to 1980 unless the solids are removed and disposed of elsewhere. A potential solution is to incorporate sludge from the lagoon into soils at the Rivergate Industrial District area. Once emptied, the lagoon will be upgraded and it may then be used again for sludge storage.

Sanitary Landfilling. This third method of sludge disposal permits sterilizing the sludge prior to dewatering and hauling to the St. Johns sanitary landfill. The treatment consists of subjecting the sludge to high temperatures and high pressure, similar to a pressure cooker. The treated sludge is then vacuum-filtered to achieve a solids content of 30-35 percent and hauled by truck to the landfill. This disposal method is not often used due to the high cost of operating the heat treatment and dewatering equipment. Also, St Johns is approaching its maximum capacity. On the basis of historical quantities hauled to this particular landfill, its projected useful volume will be reached by about 1980.

Regionalization and Sludge Quantity Projections

Regionalization Considerations. The regionalization of wastewater treatment facilities has been widely promoted for reasons of reduced cost and improved operations. The Water Pollution Control Act Amendments of 1972 encouraged the implementation of a regionalized system by requiring that at

least one alternative provide a regional approach to the project being studied. The objective of a regionalized system therefore is to provide the most cost-effective method for wastewater handling and treatment. However, the single large facility approach toward regionalization is changing to the point where the planning alone is done on a regional basis with facility construction being divided into smaller areas. The term "cost-effectiveness" has already been defined; essentially it comprises three costs: monetary or dollar costs, environmental costs, and social costs. Only the monetary costs are considered; the others are considered later in this report. Typically, environmental and social costs are judgmental. The cost-effective alternative, therefore, is that alternative judged to have the least overall social, environmental and monetary cost.

Regionalization has many advantages, including economy of scale in construction and annual operation and maintenance costs, a larger base for the distribution of costs, one operating authority for treatment facilities, treatment process efficiency control, easier incorporation of new development into the system, and the ability to plan for an area-wide or total basin. The principal disadvantage of regionalization is the loss of local autonomy wherein local governments or agencies frequently enter some kind of intergovernmental agreements in which local responsibilities are extended beyond individual member control.

An areawide Waste Treatment Management Study has just been completed by the Columbia Region Association of Governments (CRAG), which has studied numerous treatment alternatives for the greater Portland Metropolitan area and outlying communities. Regionalization was studied for four areas which are separated by natural topography. These areas are generally the service areas of the following wastewater treatment plants: the Columbia Boulevard, Inverness, Gresham, Troutdale, Sandy and Tryon Creek wastewater treatment plants; the Happy Valley, Kellogg (CCSD No.1), Oak Lodge and Tri-City plants, and possibly the Tryon Creek plant; the Unified Sewerage Agency treatment system; and the Wilsonville and Canby wastewater treatment plants.

On the basis of regionalization for sewage solids only the Columbia and Kellogg regions have any bearing on this study. The CRAG study concluded that if the Columbia Boulevard plant were expanded within the 20-year planning period (to reduce combined sewer overflows), only then would a regional plant concept become attractive for the Columbia region. If the issue of treating combined sewer overflows is not decided, then regionalization around the Gresham plant is recommended for Inverness and Troutdale with the Sandy plant remaining

autonomous. Regionalization has not been chosen. The favored method of sludge handling in all cases was by land application of liquid stabilized sludge on private lands. Sludge from the Columbia Boulevard plant is proposed to be barged to eastern Oregon for soil incorporation. The sludge from the other plants should be reused primarily on agricultural land in eastern Multnomah County and/or northern Clackamas County.

The CRAG study recommendations for the Kellogg Region would result in different handling of the wastewater and sludge. The analysis in that study indicated no preference nor significant advantage for consolidation of treatment plants. The only recommendation is that flows greater than the capacity of the Oak Lodge plant should be treated at the Kellogg plant. However, in treating sludge from these plants, a joint program of liquid sludge application to private lands is recommended as being less costly and environmentally beneficial. The CRAG study identifies the land having the greatest potential for sludge application as being southeast of Oregon City, although recognizing that other sites may also be suitable. The current practice of dewatering a nominal quantity of sludge on sand drying beds is also encouraged to provide for community reuse of the sludge.

The City of Portland's Tryon Creek plant is located within this region. Stabilized sludge from this plant is currently handled together with the sludge from the Columbia Boulevard plant, as already described, and the Facility Plan shows a continuance of this practice. However, the CRAG study analysis indicates that it may be more economical for the Tryon Creek plant to treat and dispose of sludge independently of the Columbia Boulevard plant. Two methods are suggested: the first is to operate an independent land application system in the area southwest of West Linn; the second is to realize greater cost savings by cooperating with the other Kellogg Region plants in an overall land application operation. A final recommendation was delayed, pending completion of the City of Portland's studies.

In summary, the CRAG study recommends that the Columbia Boulevard plant operate an independent sludge management system. While the study recommendations on sludge handling from the Tryon Creek plant await the outcome of current City of Portland studies.

Sludge Quantity Projections. Sludge quantity projections have been made in the Facility Plan for the City of Portland to the year 2000. The daily sludge production increase was assumed to be linear in the intervening years. The CRAG study has made some preliminary sludge projections for the other treatment plants in their study area, with the exception of the USA-Durham plant. Basically, the CRAG study assumed that because the USA-Durham plant was new and appeared to

have sufficient capacity throughout the planning period, the plant and its service area would not be included in the study. Additionally, sludge handling facilities at this plant include incineration of dewatered sludge, resulting in a significantly reduced quantity of ash to be landfilled. However, sludge quantity projections for this and the other plants in the area are reported to identify the potential volumes produced in the area.

City of Portland Sludge Quantity Projections. The City of Portland, in its Facility Plan, has projected the sludge quantity as 90 tons per day by the year 2000. This amount is produced from both the Columbia Boulevard and Tryon Creek plants and is based on a per capita contribution of sludge with an allowance for industrial contributions. The industrial allowance was estimated on what is termed a "population equivalent" basis. This is the population that would yield the same quantity of sludge that is contributed by industries. The Facility Plan identifies several assumptions upon which the projections were based, and these are reproduced here for clarity:

"a. Population and industrial/commercial contribution to sludge production will increase in direct proportion to population growth within the service area. The total 1975 service area population, including non-sewered areas, is 459,500. Between 1975 and 2000 population is expected to increase about 13 percent to approximately 522,000.

"b. Population contribution to sludge production will increase in direct proportion to the increase in population connected to the sewerage system. Currently, 66 percent or 302,684 residents of the total service area are connected. By the year 2000 it is estimated that approximately 90 percent of the service area, or 466,000 people, will be connected.

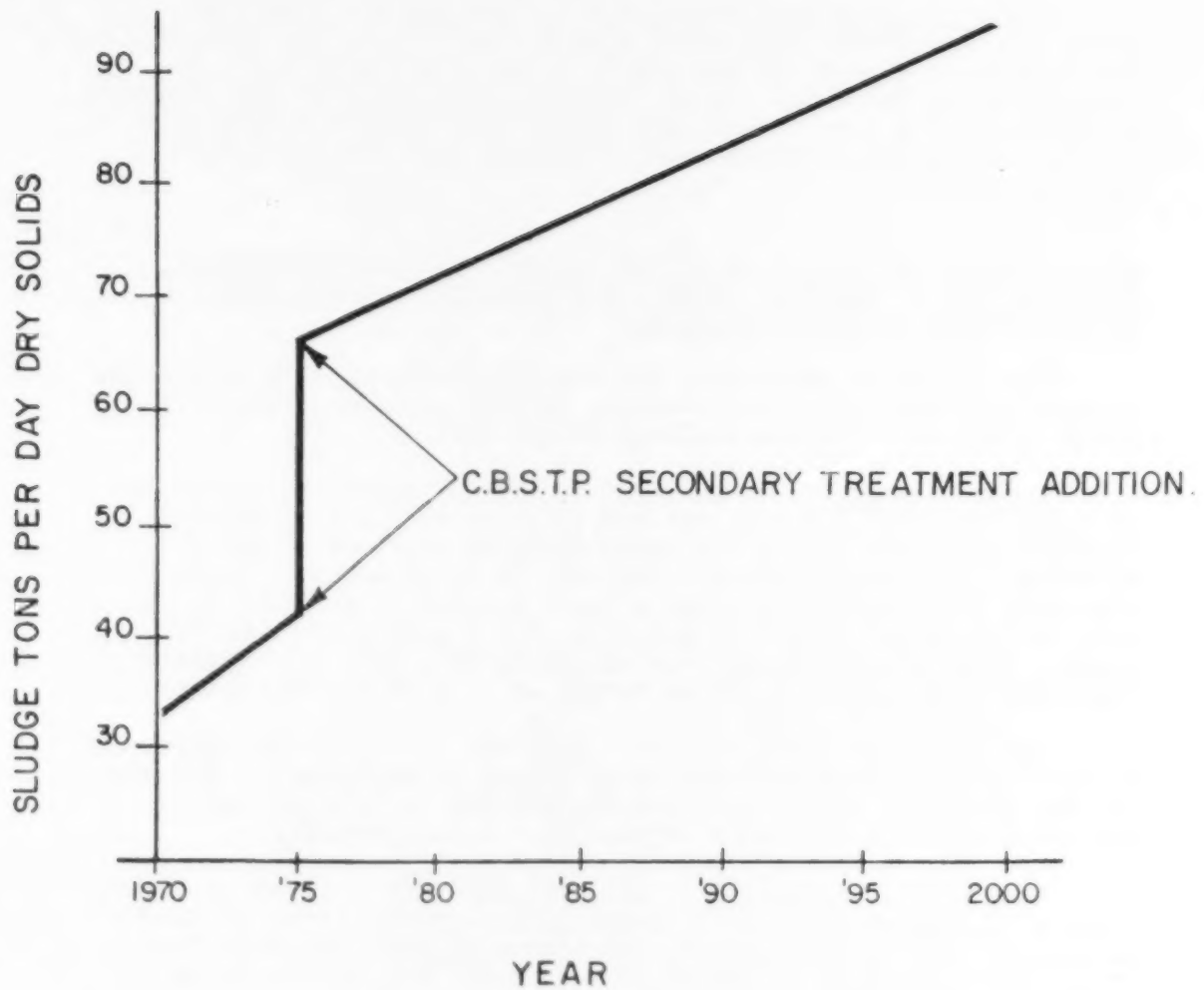
"c. Per capita contribution of sludge will increase in the Tryon Creek Service Area because of more stringent effluent quality standards for those treatment facilities discharging to the Willamette River Basin.

"d. An increase in sludge production between 1975 and 2000 is expected to occur at a uniform rate (see Figure 8).

"e. Sludge production in the six areas indicated in Section E, Intergovernmental Service Agreements, with the exception of Clackamas County Service District No. 1, is included in the sludge production figures through the study period. It is anticipated that Clackamas County Service District No. 1 will provide sludge disposal facilities at the Kellogg Creek Sewage Treatment Plant. The sludge produced in this area is not included in the final sludge production figures."

Figure 8

PAST AND ESTIMATED FUTURE SLUDGE PRODUCTION
1975 - 2000



From: City of Portland, 1976.

The historical and projected sludge quantities were graphically shown in Figure 8.

The projections presented here are again individually developed by using the influent wastewater characteristics. On the basis of the above assumptions, the strength and solids content of the wastewater are assumed to remain approximately constant with time, and only the wastewater flow is changed. The CRAG study projects a nominal increase in the per capita flow from 1975 to 2000. Table 11 shows the projected sludge quantities using the wastewater characteristics. Again, these values show close agreement with the projections in the Facility Plan.

Sludge Projections From Surrounding Areas. The CRAG study has developed projected sludge quantities for each of the treatment plants in the study area, and these are reproduced in Table 12. Also included in Table 12 are sludge projections for the USA-Durham plant that were not included in the CRAG study. These were obtained from the Unified Sewerage Agency.

Relationship of the Tryon Creek, Clackamas County Service District No. 1 (Kellogg Creek) and USA-Durham Facilities to the Sludge Disposal Program

The Columbia Boulevard STP presently receives and handles sludge from two small neighboring sewage treatment facilities: Tryon Creek STP and the Kellogg Creek STP.

Tryon Creek STP. The Tryon Creek STP presently disposes of approximately 555,000 gallons of anaerobically-digested sludge per month at the Columbia Boulevard plant or at the Rivergate industrial area. Because Tryon Creek is a part of the City of Portland system, sludge generated at that plant will be disposed of with that from the Columbia Boulevard plant. The alternatives considered in the City of Portland's facility plan included Tryon Creek as a sludge contributor.

The Portland study did not consider Tryon Creek disposing of its sludge independently from Columbia Boulevard. However, in the CRAG 208 study, an alternative was developed and analyzed which considered Tryon Creek independently.

The CRAG alternative (42a) analyzed Tryon Creek applying liquid sludge to privately owned agricultural lands in South Clackamas County possibly in cooperation with Kellogg, Tri-City and Oak Lodge. Land application of sludge for Tryon would require approximately 800 acres. Preliminary analyses by CRAG indicated that it would be more economical for Tryon Creek to treat and dispose of sludge independent of the Columbia Boulevard STP.

Table 11

PROJECTED SLUDGE QUANTITIES FOR 2000*

Parameter	Columbia Boulevard		Tryon Creek	
	(tons/day)	Plant (1,000 lbs/day)	(tons/day)	Plant (1,000 lbs/day)
Primary sludge	47.5	95	3.7	7.4
Secondary sludge	34	68	2.7	5.3
Total	81.5	163	6.4	12.7

SOURCE: City of Portland, p. 46; CRAG population estimates.

* NOTE: These sludge quantities projections were determined by using CRAG population projections, estimations of the sewer population, assumed wastewater flow rates, average per capita flows, average concentration of BOD and SS, and average removals each (65 percent) during sludge processing.

Table 12

**PLANNING AREA WASTE FLOW AND SLUDGE VOLUME FORECASTS
(CRAG 208 Areawide Study)**

Planning Area	1975	1985	2000
	Population	Population	Population
Sludge Volume (lb/day)	CASA	TfB	CASA
Columbia Boulevard ^c	404,966	425,249	437,865
Inverness	46,656	50,638	55,247
Gresham	51,204	62,316	65,937
Troutdale	2,669	5,233	11,234
Sandy	2,060	3,950	7,275
Happy Valley	2,278	3,475	5,818
Kellogg (CCSD No. 1) ^d	46,297	56,693	77,382
Oak Lodge S.D.	21,678	25,450	27,720
Tri-City	35,244	46,584	66,549
Tryon	45,609	55,049	67,606
USA-Durham ^j	91,987	124,156	155,545
USA-Rock Creek ^e	57,773	81,146	112,216
Hillsboro East (Rock Creek) ^{f,g}	7,716	12,402	16,690
Hillsboro West ^{f,g}	8,815	11,029	14,815
USA-Forest Grove ^{f,h}	12,706	17,770	23,510
USA-Gaston ^f	522	850	1,085
USA-Banks ^f	507	727	879
USA-North Plains ^f	778	1,051	1,270
Wilsonville	2,908	6,538	14,600
Canby	5,675	8,750	13,000
Molalla ⁱ	2,760	3,726	5,246
Estacada	1,620	2,578	4,508
Government Camp	510	1,220	1,545
Timberline Rim/Vernae/ Zig Zag Village/ Rhododendron	663	1,700	3,600
Total	853,621	1,008,300	1,211,142

^a Conventional activated sludge process for secondary treatment (1,927 lb of sludge produced per million gallons at influent BOD = 200 mg/l and TSS = 200 mg/l).

^b Conventional activated sludge process followed by tertiary filtration (2,081 lb of sludge produced per million gallons at influent BOD = 200 mg/l and TSS = 200 mg/l).

^c Combined sludge production of Columbia Boulevard and Tryon Plants. Taken from *Portland Sewage Sludge Disposal Studies* (September 1976).

^d Includes Rock Creek Basin (Clackamas County).

^e Sludge production based on information from pre-design report. Chemical phosphorus removal for 5 months during summer.

^f CAS year-around with land application of wastewater effluents assumed during summer months (presently used at Hillsboro West and Forest Grove).

^g Sludge production based on CRAG projected waste loadings instead of standard influent BOD and TSS values because of substantial industrial loads.

^h Average daily sludge production based on CRAG projected waste loadings instead of standard influent BOD and TSS values. Substantial summer loadings because of food processors.

ⁱ No sludge will require disposal from the proposed Molalla plant.

^j USA-Durham added to table.

Kellogg Creek. Primary sludge and thickened secondary sludge from the Kellogg Creek treatment plant are trucked to the Columbia Boulevard STP for final processing and disposal. Kellogg Creek and the City of Portland maintain an open-ended contract for sludge processing; however, Clackamas County has recently hired the firm of CH2M Hill to prepare a sludge disposal study for the Kellogg Creek plant and proposed Tri-City plant (Naef, pers. comm.). Kellogg Creek's sludge contribution to the Columbia Boulevard plant is approximately 390,000 gallons per month (CRAG, 1977).

The CRAG Sludge Management Study (1977) evaluated a regional disposal concept by Kellogg Creek, Tri-City and Oak Lodge. Eight alternatives were evaluated -- five dealing with land disposal in South Clackamas County, one evaluating barging sludge to Morrow County, and the other two dealing with landfill disposal and production of a marketable product. It was determined that approximately 915 acres of land in South Clackamas County would be needed for land application assuming agency ownership of the land and that 2,100 acres would be needed if sludge were spread on private lands.

The CRAG final-round analysis recommended the truck transport of liquid-digested sludge to South Clackamas County and spreading of sludge on privately owned farm lands (Alternative 2a). The area recommended for sludge application lies due north of the area evaluated in Alternative D of this EIS (see Figure 4). Approximately 2,100 acres of land would be needed to meet year 2000 projected needs (CRAG Technical Supplement 8, 1977).

Unified Sewerage Agency - Durham. At the time of the preparation of the CRAG Sludge Management Study, it was judged that the USA-Durham plant could be excluded from analysis because the sludge facilities and plant capacities through the 20-year study period (to the year 2000) were adequate. Recent problems with sludge processing and incineration components have caused the USA to begin a study to evaluate future sludge handling and disposal for Durham (Naef, pers. comm.). After the first-round analysis, two alternatives appear best: 1) refitting the existing incinerators, and 2) land application of liquid digested sludge.

The Durham plant presently produces approximately 8.2 tons of sludge per day and by the year 2000 will be producing an estimated 15.6 tons per day. Possible sludge application areas to be evaluated include land northwest of Durham in Washington County (south of Forest Grove and Hillsboro) (Naef, pers. comm.). An evaluation of the south Clackamas site (Kellogg region) is not anticipated.

An evaluation of the alternative of Durham trucking sludge to the Columbia Boulevard plant for disposal is also not anticipated (Naef, pers. comm.).

Constraints on Alternative Sludge Disposal Practices

The Oregon State Department of Environmental Quality has developed Proposed Regulations and Guidelines for Handling, Disposal and Use of Municipal Sludge Relating to Land Application (OAR Chapter 340, Division 4, Subdivision 2). The principal restrictions in these regulations are listed below:

- o Raw or non-digested sludge shall not be disposed of on land surfaces, but with the prior approval of the DEQ can be buried.
- o Only heat-dried sludge can be used as a fertilizer on truck crops and in public areas.
- o Sludge application in fruit or nut orchards is not permitted within 60 days of harvest.

In addition, environmental conditions may also limit the applicability of an application process or create an additional economic burden on the process. An example would be the composting of sludge which requires a maximum moisture content of about 50 to 60 percent. In the northwest area this would require a protective cover at least during the rainy season.

Finally, considering that the city operates and is committed to expanding their solids handling system, any processes proposed should be compatible with existing facilities. The existing stabilization process is committed to anaerobic digestion. Based on these conditions and the regulations published by the DEQ and the EPA, the following general observations are made.

Among the solids disposal methods that can be considered certain ones are eliminated because of agency regulations:

- o Ocean dumping.
- o Sludge lagooning (this can be used for temporary but not permanent storage).
- o Land application of raw sludge.
- o Sanitary landfilling of raw sludge.

Some of the disposal systems considered are affected by environmental conditions that constrain utility or acceptability relative to the City of Portland:

- o Air emission standards for thermal processing systems are difficult and costly to meet, resulting in less favorable consideration.

- o Composting operations require a relatively large operating area, wet weather protection and should be buffered from the public.
- o Land application systems should be buffered from the public, and require large land areas, which reduces the number of available sites.
- o Sand drying beds in the coastal climate may require wet weather protection to permit sludge dewatering and relatively large land areas for the city.
- o Crop type regulations and time of application combine to limit agricultural options for liquid sludge use as a soil conditioner/fertilizer.
- o Heat-treatment processes occasionally create an odor nuisance for surrounding areas, are energy intensive and subject to mechanical failure.

The choice of disposal systems is affected by existing and in-process facilities:

- o Sludge thickening processes, other than gravity and flotation, are eliminated.
- o Sludge stabilization by composting and lime treatment is eliminated.
- o Existing experience at the Columbia Boulevard plant does not favor the sludge conditioning processes of heat treatment because of odors and possible mechanical failure.
- o Existing commitments to anaerobic digestion makes incineration nonviable.

Some disposal systems that can be considered are adversely affected by economics and operational reliability:

- o Mechanically complex systems, such as heat treatment or mechanical sludge reduction processes are expensive, require skilled operational personnel, consume large amounts of fossil fuel and are subject to mechanical failure.
- o Sludge haul distances and the type of conveyance generally dictate the suitability of a land application system through an economic evaluation. The farther from the source that suitable lands are for sludge application, the more critical is the economic evaluation.

Based on these foregoing comments, the sludge process diagram presented in Figure 9 can now be modified to eliminate processes that need not be considered. In addition, those processes that are of low viability, as described above, are identified by cross-hatching in Figure 9.

Screening of Alternatives

This section presents a discussion of the sludge handling alternatives considered in the Facility Plan and the rationale for deleting many alternatives from additional consideration. The Facility Plan includes a further refinement of recommended alternatives by subdividing them into Phase I and Phase II. This phasing concept is also explained and discussed in this section.

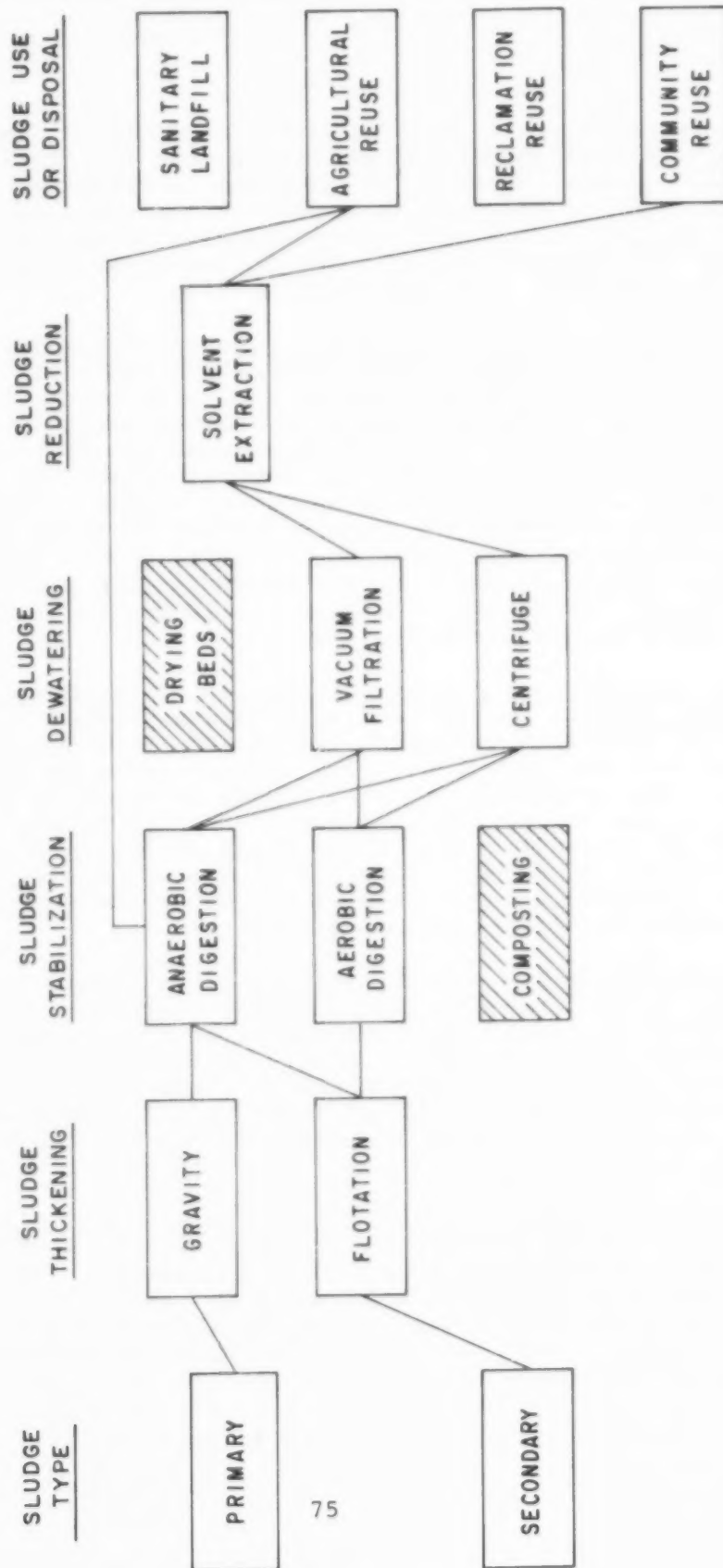
Sludge Management System Phasing. The sludge management systems considered for the City of Portland can all be divided into sludge treatment (at the plant) and sludge conveyance and disposal or beneficial use. The treatment consists of one or more combinations of the processes presented in Figure 9. Because both the Columbia Boulevard and Tryon Creek plants have existing treatment processes, any expansion or upgrading would be compatible with these processes, as was done in the alternatives developed in the Facility Plan. Of all the alternative systems initially considered, half were considered to be infeasible. Of the remaining twelve alternatives, ten included sludge stabilization by digestion. During the ranking analysis in the Facility Plan those projects that included sludge stabilization by digestion were preferred. On the basis of that analysis and the fact that the city needed additional sludge treatment components operational by 1980, due to existing capacity limitations, the Facility Plan divided the project into two phases.

The two phases essentially separate the onsite components for sludge treatment from the components required for sludge reduction, conveyance and disposal. Phase I therefore includes the construction of additional anaerobic digesters together with the cleaning and upgrading of the sludge lagoon (Triangle Lake). This phase of the project is in design and should be operational by 1980. Phase II components are considered in this EIS.

Alternative Sludge Management Systems Considered. A total of twenty-one sludge management systems were initially considered. These alternatives are briefly described in this section. In every case, the assumption was made that sludge from Tryon Creek and Clackamas could be conveyed to Columbia

FIGURE 9

FEASIBLE SLUDGE PROCESSES



Boulevard plant for final disposal without significantly affecting a recommended alternative system for the Columbia Boulevard plant. However, no analysis is presented in the Facility Plan or this EIS to show that the combined handling of the sludges is the most cost-effective method for sludge disposal for these entities. The following are the alternatives initially considered in the Facility Plan.

Alternative A-1 - Land Application of Separately Digested Liquid Sludge. This alternative provides for the transportation of liquid digested sludge by barge up the Columbia River to Morrow County, where the sludge would be incorporated into the soil. Sludge treatment is by anaerobic digestion for primary sludge and separate anaerobic digestion followed by lagooning for the secondary sludge. Digested sludge would be pumped to a barge-loading facility on the Oregon Slough and then would be barged to Morrow County. At Morrow County sludge from the barge is then pumped to a small sludge lagoon and from there it is pumped to land disposal sites for soil incorporation.

Alternative A-2 - Land Application of Separately Digested Dewatered Sludge. Under this alternative primary digested sludge is dewatered by vacuum filtration, trucked to a barge loading dock and barged for soil incorporation in Morrow County. The secondary digested sludge is again lagooned and pumped to the barges for transport to Morrow County as explained in Alternative A-1. Two types of barges would be required, one to handle dewatered sludge and the other liquid sludge. Unloading facilities at Morrow County would have to be suitable for both types of sludge.

Alternative A-3 - Land Application of Liquid Digested Sludge. As in Alternative A-1, this alternative requires land application of liquid digested sludge in Morrow County, using barge transportation. Sludge treatment is by anaerobic digestion of a mixture of separately thickened primary and waste-activated sludge. The digested sludge would be pumped directly for barge transport to the land application site in Morrow County.

Alternative A-4 - Land Application of Digested Dewatered Sludge. Thickened primary and waste-activated sludge would be blended together and anaerobically digested. The digested sludge would be dewatered using existing vacuum filters and hauled by truck to a barge loading dock for transport to Morrow County. The dewatered sludge would be off-loaded and applied to the land.

Alternative A-5 - Land Application of Digested and Heat Treated Dewatered Sludge. This alternative makes maximum use of the existing facilities by incorporating both anaerobic digestion and heat treatment for sludge processing. Thickened primary sludge would be anaerobically digested with about 20 percent of the thickened sludge being blended with thickened waste-activated sludge for heat treatment processing. Thickened waste-activated sludge in excess of the capacity of the heat treatment system would be blended with thickened primary sludge and anaerobically digested. The thickened primary sludge is incorporated with thickened waste-activated sludge for operational reasons affecting the heat treatment process. The digested and heat-treated sludge would then be blended and dewatered using existing vacuum filters and hauled by truck for loading onto barges which would transport the sludge to Morrow County. The sludge would then be incorporated into the soil.

Alternative B- and B-2 - Incineration and Landfill of Sludge Ash. Under this alternative, thickened waste-activated sludge would be conditioned by heat treatment and blended with thickened raw primary sludge prior to discharge into a decanting tank. Thickened sludge would be drawn from the bottom of the decant tank and pumped to the existing vacuum filters for dewatering. The dewatered sludge would then be conveyed to an incinerator (Multiple hearth [B-1] or fluidized bed [B-2]) where the sludge would then be burned and the resulting ash landfilled at the St. Johns or other suitable site.

Alternative C - Blended Digested Sludge Drying or Fertilizer Production. This alternative requires that the primary and secondary sludges be separately, anaerobically digested, then blended and dewatered using belt filter presses. The dewatered sludge would be conveyed to the drying system, a proprietary process called the Basic Extractive Sludge Treatment (B.E.S.T.) process. The dried sludge would then be marketed as a fertilizer in the Portland area. The drying process is new and pilot tested; however, no full-scale system is in operation. An offer has been made to the City of Portland for a 1-year money-back performance guarantee on the required process equipment.

Alternative C-1 - Separate Digested Sludge Drying for Fertilizer Production. The raw primary and waste-activated sludge are separately thickened and anaerobically digested. The digested primary sludge is dewatered and separately dried by the B.E.S.T. process. The digested secondary sludge is not thickened, but is pumped directly to a second B.E.S.T. process installation. The dried sludge would then be combined and marketed as a fertilizer. A marketing study has been done to identify and evaluate potential markets.

Alternative C-2 - Primary Digested Sludge Drying for Fertilizer Production Plus Land Application of Digested Secondary Sludge. This is basically a combination of alternatives, an alternative in which primary sludge is B.E.S.T. process treated and waste-activated sludge is barged to Morrow County. Raw primary sludge would be anaerobically digested and dewatered using the existing vacuum filters and heat dried in the B.E.S.T. process. This dried sludge would be marketed as a fertilizer. The secondary sludge would be thickened and anaerobically digested, followed by lagooning in the Triangle Lake Sludge Lagoon. Concentrated sludge from the lagoon would be transported by barge to Morrow County and there incorporated into the soil.

Alternative D-1 - Land Application of Separately Digested Sludge in Western Oregon. Alternatives D-1 and A-1 are similar except that the sludge is applied to agricultural lands in the upper Willamette Valley in D-1. Thickened raw primary and secondary sludges are separately, anaerobically digested. Liquid digested primary sludge would be hauled by tank trucks for agricultural use in the area south of Canby. The digested secondary sludge would be pumped to the Triangle Lake Sludge Lagoon for temporary storage. This sludge would also be hauled by tank truck for application to agricultural lands south of Canby.

Alternative D-2 - Barge Haul and Land Application of Separately Digested Sludge in Western Oregon. Alternatives D-1 and D-2 are identical except that the mode of sludge transport is by barge up the Willamette River in D-2. Liquid digested sludge would be pumped to a barge loading facility, and the loaded barges would transport the sludge up the Willamette River to an unloading dock. The sludge then would be pumped from the barges directly into tank trucks for land application on agricultural lands or into a sludge storage lagoon for temporary storage.

Alternative E - Composting of Digested Primary Sludge for Local Use and Land Application of Digested Secondary Sludge. Under this alternative, thickened primary sludge would be anaerobically digested, dewatered and transported by truck to the city landfill site for composting. The composted material would then be made available for community use as fertilizer aid and soil amendment. The thickened secondary sludge would be anaerobically digested, separated, and pumped to the Triangle Lake Sludge Lagoon. The solids would be allowed to accumulate and concentrate in the lagoon for about three years and then would be removed by dredging and transported by barge to eastern Oregon. The sludge would then be incorporated in the soil as previously described for Alternatives A-1 through A-5.

In addition to these alternatives, several other alternatives were also briefly considered in the Facility Plan. These additional alternatives were subsequently screened from the list without making cost estimates. The reasons for rejecting these alternatives are given at the end of each description. For convenience, these additional alternatives have been numbered consecutively with the prefix letter S.

Alternative S-1 - Ocean Disposal of Sludge. This alternative would anaerobically digest the sludge and pump the digested sludge directly into bottom dump barges. The barges would then be towed to an ocean dumping site off the west coast of Oregon and the sludge dumped.

As already stated this method is not approved by the EPA and, in fact, east coast cities that have used this method for a number of years have been ordered to stop. In addition, the Department of Environmental Quality (DEQ) prohibits the ocean dumping of sewage sludge. This method is controversial, has not received public acceptance, and has been dropped from further consideration.

Alternative S-2 - Pyrolysis of the Sludge and Landfill. This is a sludge reduction method in which organic material in sludge is decomposed at high temperature in an oxygen-deficient environment. Three products result from this process, gas, oil and char (solid residue). The system is intended to be self-supporting and to generate sufficient heat to provide an excess for other uses. The process has been used on municipal refuse in many areas, but has not been demonstrated to be reliable in full-scale operations on sewage sludges.

Alternative S-3 - Sanitary Landfilling of Dewatered Sludge. This alternative would require that stabilized sludge be dewatered and hauled by truck to a sanitary landfill for disposal. Stabilization would be by anaerobic digestion, as presently practiced. However, there would have to be a substantial increase in the construction of dewatering facilities to yield the necessary minimum solids concentration of 20 percent. Also, a truck transport fleet and a suitable landfill site would be required.

Sludge disposal by sanitary landfill was screened from more detailed consideration for the following reasons: 1) there is no possibility of providing a beneficial use for the sludge; (2) a sanitary landfill site could not be located within a reasonable distance of the Columbia Boulevard plant; (3) truck transport of sludge is generally more expensive than other means of transport, such as barge or pipeline; and (4) there would be a requirement for additional dewatering facilities. Considered together this method would be more expensive and neither beneficial nor environmentally acceptable.

Alternative S-4 - Oil Tanker Ballast to Oil-Producing Countries. This alternative has been suggested by many people as being logical and environmentally beneficial. The idea is simple. Middle East oil tankers, which presently use water as ballast for their return journeys, could replace the water with liquid digested sludge. Once at the country of origin, the sludge could be used to reclaim desert lands through its use as a soil conditioner or binder to provide waterholding capacities to the sands.

Although this alternative represents a beneficial use of the sludge, and at minimal cost to the city, implementing such a scheme would pose an insurmountable obstacle. International politics would be involved and agreements would have to be arranged, so that the scope of such an undertaking would be well beyond the resources, or perhaps even the authority, of the city.

Alternative S-5 - Sludge Reduction by Heat Drying. Sludge reduction would be achieved by evaporation drying. Because Alternatives C, C-1 and C-2 provide essentially the same product through the solvent extraction method, and because drying tends to be more expensive, consumes more energy and requires more air pollution control equipment, this alternative was not considered further.

Alternative S-6 - Application on Forest Lands. This alternative requires the application of either dewatered or liquid digested sludge onto forest lands to enhance the growth of trees. The feasibility of this system is directly related to transportation distances, topography, density of undergrowth and whether control of run-off and leachate is necessary. For the City of Portland, suitable forestry sites are a considerable distance away and transportation costs would consequently be high. Also, the application costs would be much higher than for those alternatives that included soil incorporation in eastern Oregon.

On the basis of the experience of the Municipality of Metropolitan Seattle, the unit cost for this type of disposal is significantly higher than for the other alternatives considered. The cost was based on estimates that a suitable forest site could be found within 30 miles (one way) of the Columbia Boulevard plant, estimated at \$90. per ton of solids. As will be shown, this is significantly higher than the other alternatives.

Alternative S-7 - Land Application of Digested Sludge Downriver from Portland. This alternative is similar to Alternatives A-1 through A-5 except that the land application site was downriver from the City of Portland. Again, the sludge would be barged to a suitable site for sludge application on riverfront lands. The application would provide soil conditioning and the enhancement of wildlife habitat.

On the basis of preliminary study, appropriate land acreages were not evident. Also, a majority of the suitable lands are in the Columbia River floodplain where the groundwater table is close to the surface. Therefore, this alternative was not considered further.

Alternative S-8 - Sludge Pelletizing for Land Utilization. This system requires that stabilized, dried sludge be pressed in pellets for use as a fertilizer. Many agencies have investigated the economics of pelletizing for the nutrient value of the sludge, but the economics of the process have not been favorable. In addition to costs for drying sludge, there are additional capital and operational costs for pelletizing equipment. Another problem is one of an uncertain market value for the pelletized product.

Because of these uncertainties and high initial costs, this process was not considered in further detail. Also to be considered are the results of an investigation by the Forestry Products Industry. Their investigation disclosed that truck transportation of low-nutrient pellets and their application over forest lands from aircraft is not as cost-effective as the purchase and similar application of high-nutrient, commercialized fertilizer.

Alternative S-9 - Conversion of Sludge to Livestock Feed. Many scientists and researchers have suggested that sludge be converted to livestock feed because of the high protein and nutrient value of the material. The Coors Brewing Company of Golden, Colorado, has done some research on their brewery waste which is proving attractive. However, the U. S. Food and Drug Administration (FDA) will not approve the product because it has some traces of human waste in the wastewater (less than 5 percent). Because of the problems associated with FDA approval of wholly municipal sludge conversion and the fact that approved conversion methods have not yet been developed, this alternative was not considered further.

Other alternatives can be conceived such as composting in furrows with grass straw that is presently burned and composting in soil with cellulose wastes from paper plants. However, all conceivable alternatives have not been considered in depth due to the overwhelming number of possibilities and the lack of technical, economic or social feasibility.

Summary of Alternatives

Twenty-two alternative sludge management plans have been described briefly. Thirteen were evaluated in detail by the Facility Plan and nine were dismissed from further consideration for the reasons described above. A critical

review of the candidate systems to be evaluated shows that these alternatives actually represent modifications or combinations of only three basic alternatives. These are as follows: (1) land application of digested sludge; (2) incineration and landfill of the resulting ash; and (3) sludge drying for production of a fertilizing aid.

Estimated Annual Cost of Alternatives. The City of Portland prepared cost estimates, including both capital and operation and maintenance costs for each of the alternative sludge management systems. These costs are summarized in Table 13. For more details on these costs, the reader is referred to the Facility Plan.

Also included on Table 13 are the equivalent basic alternative numbers to determine which of the detailed alternatives can be represented by one of the three basic management plans discussed. Inspection of the table shows that the land application alternatives are the least expensive followed by sludge drying using solvent extraction and, lastly, the incineration system. Moreover, land application in the northern Willamette Valley and a combination of land application and composting prove to be the most expensive of all the alternatives.

Based on the premise that any cost estimates within 10 percent of each other can be considered equal, Alternatives A-1, A-2, A-3 and C-1 are cost equivalent.

Rationale for Selection or Rejection of Alternatives from Further Consideration. Although Alternatives A-1, A-2, A-3 and C-1 can be considered cost equivalent, cost alone was not used for the selection or rejection of alternatives for more detailed consideration. The following discussion, on an alternative by alternative basis, presents the rationale for selection or rejection of the remaining thirteen alternatives.

Alternative A-1 - Land Application of Separately Digested Liquid Sludge. This alternative was retained for detailed evaluation. It is the lowest cost alternative, and consumes less energy than any of the other "A" alternatives.

Alternative A-2 - Land Application of Separately Digested Dewatered Sludge. This alternative was deleted. Due to the use of two different types of barges, for dewatered and liquid sludge, it is unnecessarily complex and lacks flexibility. Although only slightly more expensive than A-1, it is more energy intensive.

Table 13

ESTIMATED TOTAL ANNUAL COSTS - ALL ALTERNATIVES¹

Alternatives		Capital Costs (\$1000's)	Amortized Capital Costs (\$1000's)	O & M Costs (\$1000's)	Total Annual Costs (\$1000's)
Basic Number	Detail Number				
I	A-1 ³	11,555.5	1,059.2	1,043.3	2,102.5
I	A-2	11,417.6	1,046.5	1,208.2	2,254.7
I	A-3	12,076.4	1,106.9	1,166.2	2,273.1
I	A-4	9,495.4	870.4	1,243.1	2,113.5
I	A-5	5,365.3	491.8	2,088.1	2,579.9
II	B-MH	8,540.5	782.8	2,259.2	3,042.0
II	B-FB	10,931.6	1,002.0	1,976.4	2,978.4
III	C	11,634.5	1,066.4	1,594.0	2,660.4
III	C-1 ^{2, 3}	12,471.9	1,143.2	1,079.0	2,222.2
III	C-2	12,833.5	1,176.3	1,232.0	2,408.3
I	D-1	12,505.7	1,420.1	1,777.7	3,197.8
I	D-2	16,325.3	1,577.3	2,008.7	3,586.0
I	E	13,045.7	1,252.6	1,944.1	3,196.7

¹ These values represent the updated cost estimates (1977) for the alternatives presented in the facility plan. The costs for the three selected alternatives were updated by the City of Portland in April 1978 and these costs are presented in Appendix F.

² B.E.S.T. Process

³ Alternative A-1 and C-1 costs do not include any revenue from the sale of sludge.

Alternative A-3 - Land Application of Liquid Digested Sludge. This alternative was deleted. A key consideration was the lack of long-term sludge storage and treatment in the Triangle Lake Lagoon, as accomplished in A-1. The lack of treatment which would be provided by this long-term storage could cause some instability in the final product. Odor, fly and pathogen problems could result. An additional consideration in rejecting this alternative was the extremely high energy requirement.

Alternative A-4 - Land Application of Digested Dewatered Sludge. This alternative was deleted. Although slightly less energy intensive than A-1, A-4 was deleted primarily due to its high annual operation/maintenance cost.

Alternative A-5 - Land Application of Digested and Heat Treated Dewatered Sludge. This alternative was deleted. Although capital costs are low, due to use of existing facilities, the operating cost is extremely high. Overall, the annual costs are about 25 percent higher than A-1. Additionally, A-5 is a very energy intensive process.

Alternative B-1 and B-2 - Incineration and Landfill of Sludge Ash. These alternatives were deleted. Use of incineration, either multiple hearth (B-1) or fluidized bed (B-2), is incompatible with the on-going Phase I project. In reality, this alternative was eliminated from consideration even prior to the Facilities Plan, due to the strong public reaction which followed its initial proposal.

Alternative C - Separate Digested Sludge Drying for Fertilizer Production. This alternative was rejected. It is roughly 20 percent more costly than C-1, yet provides no advantage over C-1. This is the primary reason for rejection.

Alternative C-1 - Separate Digested Sludge Drying for Fertilizer Production. This alternative was retained for detailed evaluation. It is the least costly of any "C" alternative, and has operation/maintenance and total annual costs nearly equivalent to A-1.

Alternative C-2 - Primary Digested Sludge Drying for Fertilizer Production plus Land Application of Digested Secondary Sludge. This alternative was deleted. It exhibits no cost or other advantages over C-1, assuming of course, that a sufficient market can be developed for the greater volume of dry sludge produced by C-1.

Alternative D-1 and D-2 - Land Application of Separately Digested Sludge in Western Oregon. These alternatives were retained for detailed evaluation. Although neither shows a cost advantage over A-1 or C-1, EPA desired that these alternatives be retained. The EPA decision was made principally on the basis of retaining a Western Oregon land application alternative in the detailed evaluation.

Alternative E - Composting of Digested Primary Sludge for Local Use and Land Application of Digested Secondary Sludge. This alternative was deleted. In addition to having an annual cost 50 percent greater than A-1, space requirements, labor intensity, and the necessity for protection from rainfall were the principal reasons for deletion.

Description of Selected Alternatives

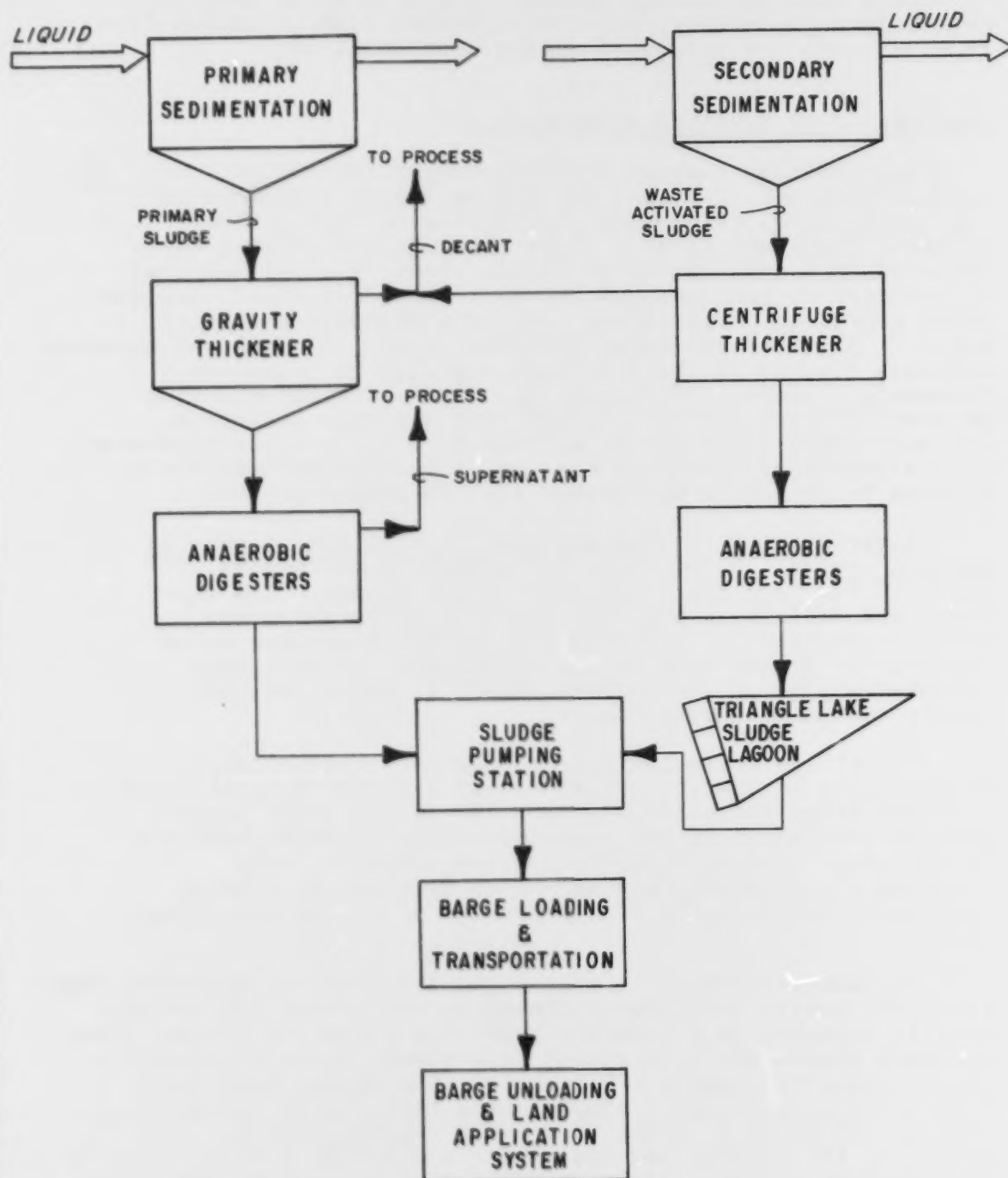
The previous section in this chapter identified Alternatives A-1, C-1, D-1 and D-2 as viable solutions to the sludge handling problem at the City of Portland's Columbia Boulevard plant. These alternatives consist basically of land application of liquid sludge for agricultural or reclamation purposes and the marketing of B.E.S.T. process dried sludge as a fertilizer aid. The predominant use of B.E.S.T. dried sludge would probably be one of local and possibly national use, as is the case with the City of Milwaukee, Wisconsin's product, Milorganite. These alternatives will be described and a more detailed cost analysis presented. One additional alternative, similar to C-1, is also considered. This alternative considers the use of the Carver-Greenfield process to produce a marketable soil amendment product.

Alternative A-1, Land Application of Liquid Sludge in Eastern Oregon. Alternative A-1 exists as an optional category for land application of liquid sludge. The elements and facilities required for this alternative are shown schematically in Figure 10, and are described below. The overall system entails the transportation of liquid digested sludge up the Columbia River by barge for soil incorporation in Morrow County.

The sludge collected from the primary sedimentation basins would be gravity thickened and anaerobically digested in a two-stage digestion system. The second stage permits partial thickening of the digested sludge to concentrations in the range of 7 to 8 percent solids content. This digested sludge would then be pumped directly to a barge loading facility on the Oregon Slough and loaded into river barges.

The waste-activated sludge collected from the secondary sedimentation basins would be thickened by centrifuge and anaerobically digested in a separate two-stage digestion system. The digested sludge would be pumped to a sludge storage lagoon where sludge thickening would occur. The lagoon used for this thickening process, the Triangle Lake Sludge Lagoon, will be renovated by cleaning out the existing sludge, enlarging the lagoon, and installing additional sludge distribution piping. After the sludge discharged to the lagoon has settled and consolidated, the free standing water

FIGURE 10
**SCHEMATIC DIAGRAM
FOR ALTERNATIVE A-1**



above the deposited solids, supernatant, would be drawn off through three polishing ponds prior to being pumped to the primary sedimentation basins. After about 3 to 4 years the concentrated sludge will be pumped to the barges for loading, conveyance and land application. The refurbishment of Triangle Lake is presently in the design stage under Phase I of this project.

All liquid digested sludge would be conveyed by barge approximately 150 miles up the Columbia River to Morrow County. A barge unloading dock would be constructed at a location west of the City of Boardman. The liquid sludge would be pumped off the barge to a holding pond located on the land application site.

The land application technique has not yet been selected; however, the technique eventually chosen will be dependent upon more detailed analysis of the specific site. The system would probably be one of the following:

- o The sludge could be pumped from temporary storage facilities through pipes to a special injection device being towed behind a tractor. The injection device, similar to a plow, provides a means for pumping the sludge directly under the ground surface. The injector is connected to the permanent piping by a long, flexible, reinforced hose attached to above-ground valves. The amount of sludge applied per acre is adjusted by varying the speed of the tractor. This method essentially eliminates the potential for odor or vectors and other nuisance conditions.
- o Liquid sludge could be pumped through piping to large orifice sprinkler guns. These "guns" can cover a large area and many are self-propelling. After application the sludge is plowed into the ground with a discing plow.
- o A third method is to spread liquid sludge from specially designed tank trucks. The trucks would be filled from either the temporary storage lagoon or directly from the barge. These tank trucks would then spread the liquid sludge on the ground. Again, this sludge would be ploughed into the ground using a disc.
- o Finally, the sludge could be pumped into shallow drying beds or lagoons. The sludge is then dried using the high net evaporation rate in Morrow County. The dried sludge would be spread on the ground and plowed into the soil to avoid odor and vector proliferation. Dried sludge could also be stored during inclement weather for land application in other areas.

This description of Alternative A-1 provides the basis for identifying the capital improvement facilities and operational and maintenance (O & M) practices required for the project. These facilities, the estimated capital, and O & M costs are presented.

Alternative C-1, Sludge Drying for Production of Fertilizer Aid. Alternative C-1 is covered by the third basic alternative sludge management system of sludge drying for the production of a fertilizer aid. The elements and facilities required for this alternative are shown schematically in Figure 11 and are described in detail below. The overall system includes drying of the digested primary and secondary sludges by a solvent extraction method. The product would then be marketed in the northwest.

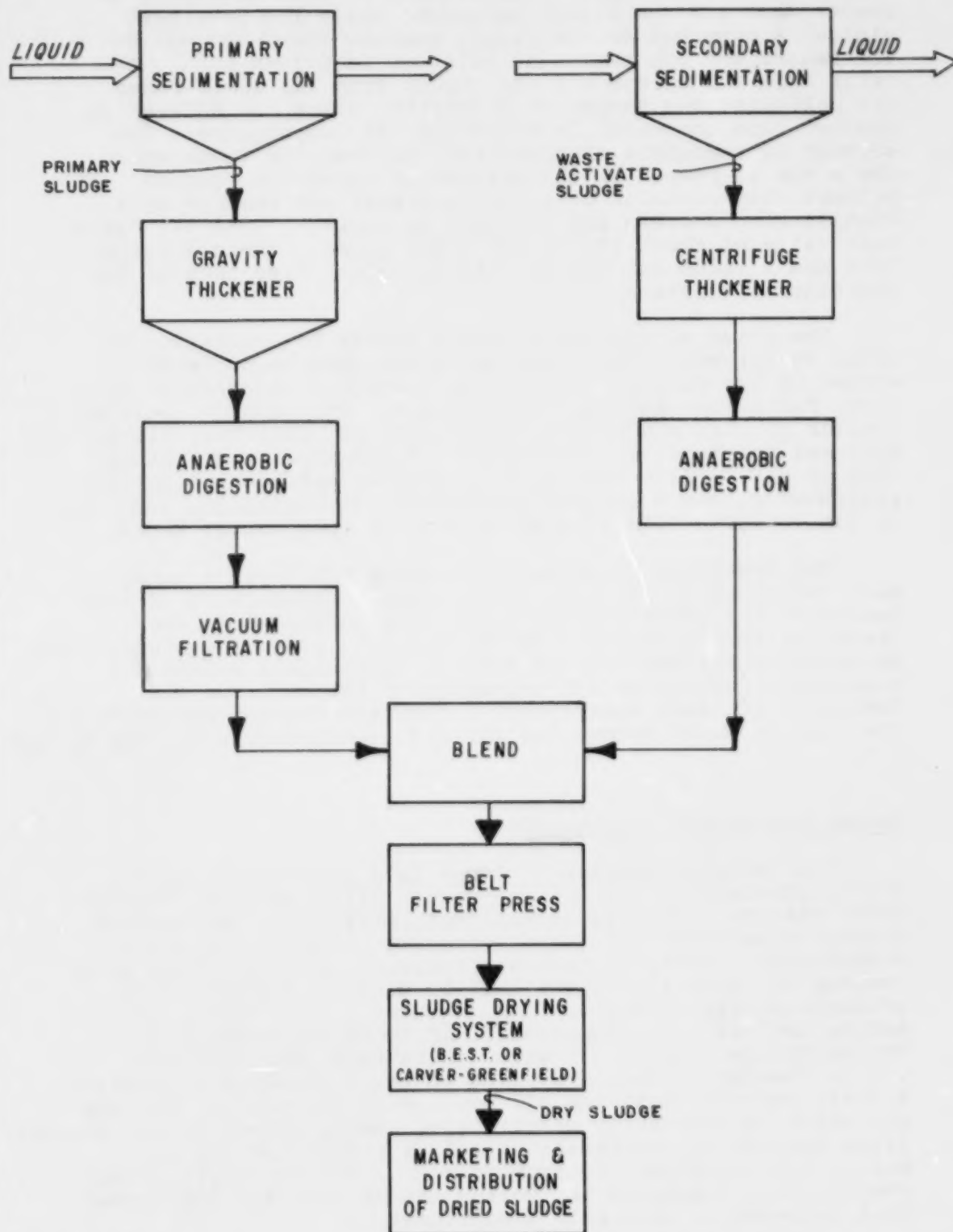
The process schematic has been revised based on 1977 pilot-plant studies by adding a blending step for combining the primary and secondary sludges, adding a belt-press dewatering step, and replacing two smaller drying units with one larger unit.

The sludge from the primary sedimentation basins would be gravity thickened and anaerobically digested in a two-stage digestion system. The second stage digester is used to settle and thereby thicken the sludge in the range of 7 to 8 percent solids concentration. This thickened sludge would then be pumped to vacuum filters for dewatering to a cake concentration of 25 percent solids.

The waste-activated, or secondary sludge collected from the secondary sedimentation basins, would be thickened by centrifuges and anaerobically digested in a two-stage digestion system. Because digested secondary sludge does not settle or thicken easily, the second stage is used only for additional digestion and storage. The reason for including the second stage is to provide the flexibility of combining the sludges in the future for digestion and thickening. The digested liquid sludge from the second stage is pumped to a tank where it is blended with the primary sludge cake. The mixture is belt-press dewatered to 20 percent solids before drying.

The proposed sludge drying system is a proprietary process called Basic Extractive Sludge Treatment (B.E.S.T.) process. The process is being developed by the Resources Conservation Company, which is a totally owned affiliate of Reading and Bates Offshore Drilling Company and the Boeing Company. The B.E.S.T. process is designed to utilize the unique properties of an industrial solvent (Triethylamine) to enhance the extraction of the water in the sludges. Side benefits of using this solvent involve the collection of oils and fats from the sludge during the final drying process.

FIGURE 11
**SCHEMATIC DIAGRAM
FOR ALTERNATIVE C-1**



The system is described very briefly here. The sludge entering the process is mixed with the solvent and the temperature reduced to 60°F, at which point the solvent and water become totally miscible. The mixture is then dewatered in centrifuges and the liquid collected while the dewatered sludge is conveyed to the drying process where the solids are heated and the remaining moisture is driven off. The vapor from the driers and the liquid from the centrifuges are collected and pumped to a decanter where the solvent is removed from the water by adjusting the temperature. The solvent is therefore captured and returned for reuse while the water is pumped to the wastewater treatment process. The solvent also contains oils and fats that are removed by a distillation process and conveyed to storage. The oil has a heat value of about 16,000 BTU's per pound. The oil therefore has a value and can be sold to help defray some of the operational expenses.

The dried sludge would have a solids concentration of about 95 percent. This material would then be marketed, either by the City of Portland or through a contractor, as a light fertilizer and soil conditioner. The product would be similar to that produced by the Cities of Milwaukee, Wisconsin, and Los Angeles, California. Typical nutrient quantities of the product consist of 4 percent nitrogen, 4 percent phosphorous, and 3 percent potassium. The marketing and sale of the product would also alleviate the operational costs.

The Resources Conservation Company has given a money-back guarantee to the City of Portland. Under terms of this guarantee the Company would train city personnel in the operation and maintenance of the B.E.S.T. process equipment and demonstrate its performance against operational parameters previously formulated and agreed to by the city and the Company. If these operational parameters are not achieved, the Company would remove the B.E.S.T. equipment at no cost to the city.

Carver-Greenfield Alternative

The Carver-Greenfield Process is a proprietary sludge drying process, in which light oil is mixed with the sludge-water mixture. The sludge-water-oil mixture is then passed through a multi-effect evaporator, and water is removed by evaporation. Although the manufacturer claims that the water removed is virtually "distilled" in quality, considerable evidence exists to support the contrary. The purpose of adding the oil is to increase fluidity of the mixture as drying occurs. After all water is removed, the remaining oil is removed by centrifugation of the oil-solids suspension. A small percentage of the oil remains in the sludge, but the oil which is removed by centrifuging may be reused in the process. After removal of the remaining oil, a portion of the dry solids are pyrolyzed, to provide energy for the multi-effect evaporator. Remaining dry solids may be used for additional fuel purposes or as a soil conditioner.

In this alternative, separate anaerobic digestion of primary sludge and waste-activated sludge is accomplished using two-stage digestion. In the second stage, the digested sludge thickens by gravity to 8 percent solids. The two digested sludge streams are then combined and passed through a centrifuge, to thicken the sludge to approximately 20 percent solids. Sludge then enters the Carver-Greenfield Process treatment. The resultant sludge produced by the Carver-Greenfield Process is normally over 95 percent solids. A schematic flow diagram for the Carver-Greenfield Process is shown in Figure 12.

Cost Analysis. Costs for purchasing, operating, and maintaining the Carver-Greenfield Process were obtained from the manufacturer, Dehydro-Tech Corporation of East Hanover, New Jersey. These costs were combined with costs for digestion, cleaning of the Triangle Lake Lagoon, and for electrical generating equipment to determine the present worth cost of this concept. These costs are presented in Appendix G.

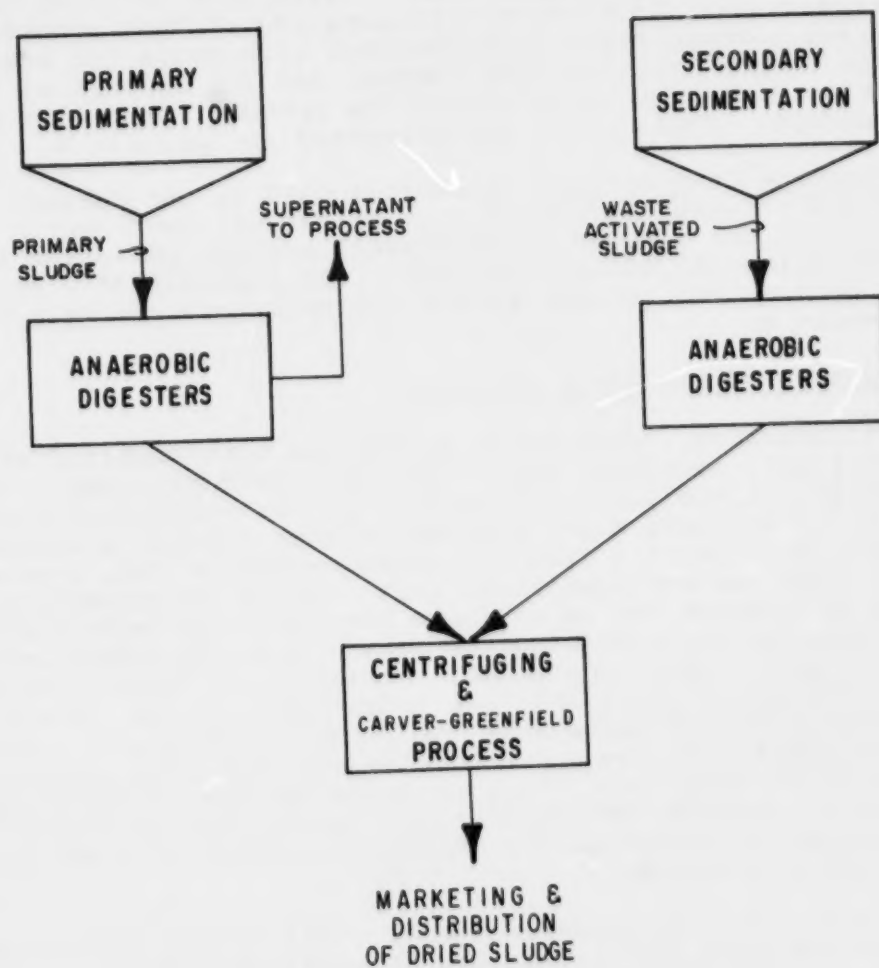
Resource Consumption. Resources used in the Carver-Greenfield Process are electricity (5,325,080 kw-hr/yr), makeup light oil (44,000 gallons/year) and polymer prior to centrifugation (87,600 pounds/year). An analysis of electrical energy consumption for the entire treatment process is shown in Appendix H.

Summary of Marketing Analysis.

Introduction. Heat-dried sludge has been marketed elsewhere as both a soil amendment and a low-analysis fertilizer. An assessment of the feasibility of disposing of the heat-dried sludge which the City of Portland might produce, either through a commercial marketing program or a free distribution system, was conducted and its findings are summarized here. While the primary purpose of this assessment was to estimate the amount of heat-dried sludge which could be marketed or given away, other important information was developed. First, potential retailers and users indicated product characteristics that are important to them. One of those characteristics was inevitably the price of the product which was then related to the volumes retailers and users estimated they would purchase in order to develop the demand estimates given here. Second, descriptions of many of the characteristics which appear to determine the long-term success of a marketing program were developed.

Background. The experiences of other sludge marketing programs are important indicators of market parameters. A brief survey of past and present marketing programs in the Portland, Los Angeles, Milwaukee, Houston, Amarillo, Corpus Christi and Birmingham areas indicated the following:

FIGURE 12
**SCHEMATIC DIAGRAM FOR
CARVER-GREENFIELD
PROCESS ALTERNATIVE**



Successful marketing programs do not result in sufficient revenues to pay the agency's treatment costs. A marketing program may be one element of a sludge disposal system which minimizes total disposal costs. Successful operations typically involve a private contractor in addition to the treatment agency. In some cases the contractor is paid to take the sludge as it comes from the treatment process and in the other cases the contractor pays the agency for a more finished sludge product.

All successful marketing programs are characterized by consistent quality control in the production process. There is likewise a history of failures primarily attributed to user dissatisfaction caused by variable product quality.

All successful marketing operations seem to exercise some control over their markets. This control has been exercised either through a brand name which differentiates the product from comparable products or through simply being at least the only sludge-based product.

No examples of sludge marketing programs which attempted to serve all potential markets for such a product were found. Whether by planning and design or by trial and error, all successful operations operate with products and marketing approaches that are pinpointed to specific user groups. These user groups can generally be classified into three types of markets: agriculture, professional or specialty, and home and garden.

The discussion of the findings which follows is divided into three sections, each dealing with one of the markets mentioned above. At the conclusion of these discussions are a summary of the feasibility assessment and a discussion of approaches to implementation and potential outcomes.

The agricultural market. Growers in the Portland area use vast quantities of fertilizers. For example, about 25,400 tons of fertilizer containing 30% nitrogen is required to fertilize wheat and barley crops in the four counties surrounding Portland. Assuming the heat-dried sludge product has a nitrogen content of 4%, which is a conservative but realistic estimate of its content, it would take 402,000 tons of sludge to provide the same amount of nitrogen to the same crops.

Sludge has not been widely used in commercial agriculture. Recent research by Oregon State University estimated a return to land and management from sludge use of -\$3.30 to \$8.30 per ton of sludge used assuming the sludge were provided delivered and spread free of charge. It is estimated that delivery and spreading costs would be from \$8.50 to \$10.00 per ton leaving the sludge itself with a negative value. It was therefore concluded that a commercial marketing program serving agriculture would not be feasible.

Growers of grain crops and perhaps some other crops would be willing to accept sludge if it were delivered and spread. While they would not pay anything for the sludge and would not pick it up or spread it themselves, the growers might be willing to pay some of the delivery and/or spreading cost if they were convinced of the nutrient value of the sludge for their crops. The sludge would have to be distributed to users on schedules coordinated with their planting programs, not with the production of the sludge.

The specialty market. Table 14 lists the general uses and significant user groups which comprise the specialty market for soil amendments and fertilizers.

Table 14

SPECIALTY USES AND USERS

General Uses:	<u>New Landscaping</u>	<u>Landscaping Maintenance</u>	<u>Plant Propagation</u>
Significant Users:	Landscape architects and Landscape contractors	Landscape contractors Golf course operators Cemetery operators Public park districts Public works departments Schools & colleges State highway maintenance divisions US Forest Service	Field nurseries Container nurseries Turf growers Grass and other seed growers

SOURCE: Gruen Gruen + Associates

Landscape contractors use between 215,000 and 270,000 cubic yards of soil amendments annually in the Portland area for both new landscaping and maintenance of existing plantings. Most of the soil amendment is barkdust although some steer manure is also used. Since bark is becoming more valuable as an energy resource, it is expected that there will be an increasing market for soil amendments such as heat-dried sludge. If landscape architects, who frequently specify which material will be used, are convinced of the horticultural value of the sludge product, it is estimated that a market for 100,000 to 140,000 tons would be created. This estimate is based on assumptions that: the sludge product will be priced at \$4.50 to \$5.00 per cubic yard, comparable to barkdust; the sludge will have no weed seeds, have a granular texture which is not dusty and does not solidify in storage and have mulching qualities similar to other organics; and will be readily and consistently available.

Of those who maintain landscaping, only golf courses, park and public works departments, and schools indicated any demand for a sludge product at a price greater than zero. The estimated demand for these three user groups is only about 300 tons per year at a price of \$7.50 to \$11.25 per ton, comparable to the price they are paying for the manures and barkdust they currently use. This estimate is contingent upon the same product characteristics described in the previous paragraph. These users were only willing to use the product as a substitute for the soil amendment they currently use on the small amounts of new or replacement planting they do annually. If the heat-treated sludge were made available free-of-charge, these three users would increase their volume and the US Forest Service and highway department would use some as well for total use of as much as 22,000 tons per year. Much of the additional uses which would be made if the product were free reflect needs which it is not economic to satisfy with products available commercially.

Among plant propagators only container nurseries would consider purchasing heat-dried sludge at a price above zero. They would be willing to purchase between 640 and 850 tons per year to use as a part of their potting mixes if it has the properties described previously and were available for \$6.75 to \$7.50 per ton. If the product were offered free-of-charge on a delivered and spread basis, turf farms, field nurseries and rye grass seed growers would use from about 75,000 to 95,000 tons of heat-dried sludge annually. These specialty users are like commercial agricultural users in that the product must be delivered and spread on a schedule adapted to their individual growing cycles.

The home and garden market. Three different home and garden uses for a sludge product were identified in the Portland area. First, there is a significant local trade in soil amendments, primarily barkdust and most of which is sold in bulk, estimated at 45,000 to 60,000 tons annually. Since bark supplies available to the home and garden soil amendment market are being affected by the same forces as those available to the specialty market (in fact, many bark dealers serve both markets), it was estimated that the sludge product would be substituted for about 50% of the material currently sold for this purpose or 23,300 to 30,000 tons per year. This estimate is conditioned upon the assumption that the sludge would be sold at \$6.75 to \$7.50 per ton, a price comparable to that of wood products. Home and garden soil amendment users are not as sensitive to the characteristics of the product as specialty users, but they will not accept an odorous product or an excessively dusty one.

The second potential home and garden use of heat-dried sludge identified and studied in this effort is as an ingredient in a potting soil. It is estimated that approximately 27,000 tons of potting soils are marketed in Oregon, Washington and

Idaho annually. If the sludge product did not have an objectionable odor or potentially damaging concentrations of heavy metals it would be substituted for much of the wood products used in these mixes currently. If the sludge were sold at \$6.75 to \$7.50 per ton it is estimated that this market might amount to 6,700 to 9,300 tons per year.

Finally, northwestern gardeners use an estimated 3,000 tons of organic-base fertilizers annually. These fertilizers are manufactured primarily by three firms in the area, each of whom feels there will be the potential to expand sales to as much as three times its current level in the near future if the price of chemical fertilizers continues to rise. Heat-dried sludge provides a very acceptable organic base for such fertilizers and the firms accordingly are willing to pay \$10.00 to \$50.00 per ton depending on its nutrient content. Since only one of these producers is in the Portland region - the other two are nearer the City of Seattle, which is also studying the feasibility of producing and marketing a heat-dried sludge - this potential market for Portland's heat-dried sludge has been estimated at 3,000 tons annually.

Summary of Conclusions. Table 15 presents a summary of the volumes of heat-dried sludge estimated to be marketable at the given prices and of the volumes which could be distributed free-of-charge to various users. These estimates indicate that it would be feasible to market all of Portland's sludge if it were heat-dried. Additionally, if the city did not desire to undertake a marketing program, there are willing users for many times the city's potential production if the material were offered free-of-charge. It should be recalled, however, that many of this latter group would only accept the sludge if it were also delivered and spread for them on a schedule coordinated with their activities.

Implementation strategies. One alternative would be for the city to set up a free distribution program at the treatment plant. Demand is likely to be seasonal and unpredictable. No revenue would be produced though only minimal costs, in addition to the heat-drying, would be incurred.

Another alternative would be to distribute the product free-of-charge to one or a few large users. While the arrangements for such a program could provide greater assurance that all the sludge would be used, large users are the most likely to require delivering and spreading as a condition of acceptance of the sludge. This type of a program might, therefore, be more costly than the first type.

Finally, the city could sell the heat-dried sludge to a marketing contractor. The research necessary to estimate the potential return to the city from a marketing program was not

Table 15

SUMMARY OF CONCLUSIONS
MARKETING ANALYSIS

<u>Potential Markets</u>		<u>Potential Markets</u>	
<u>Market</u>	<u>User</u>	<u>Volume (Tons/year)</u>	<u>Price (\$/ton)</u>
Specialty Markets	Landscape architects & contractors	100,000-140,000	6.75- 7.50
	Golf courses	130	7.50-11.25
	Parks & public works	100-130	7.50-11.25
	Schools	70	7.50-11.25
	Container nurseries	640-850	6.75- 7.50
Home & Garden Market	Soil amendment	23,300-30,000	6.75- 7.50
	Potting soil ingredient	6,670-9,330	6.75- 7.50
	Organic fertilizer base	3,000	40.00-50.00
<u>Potential for Free Distribution</u>			
<u>Market</u>	<u>User</u>	<u>Volume (Tons/year)</u>	
Specialty Markets	Parks & public works	2,670-3,330	
	Schools	825-1,010	
	Golf courses	630	
	Highways	210	
	US Forest Service	17,600	
	Rye grass seed growers	60,000	
	Turf farms	3,170	
	Field nurseries	15,000-30,000	
Agricultural Market	Wheat & barley growers	402,000	

SOURCE: Gruen Gruen + Associates

undertaken in this study. The potential return and exact volume likely to be marketed would depend on the marketing strategy pursued. For instance, at one extreme would be a strategy aimed at maximizing sales by serving as many of the markets as possible and by maintaining a low price. At the other extreme would be a strategy aimed at maximizing the return per unit sold by restricting the volume sold and markets served and by heavily advertising in order to differentiate the city's sludge product from other soil amendments and/or fertilizers in the eyes of the users. Somewhere between these extremes lies an optimum strategy for the city. The primary determinant of optimality should be the relative cost of heat-drying and marketing programs.

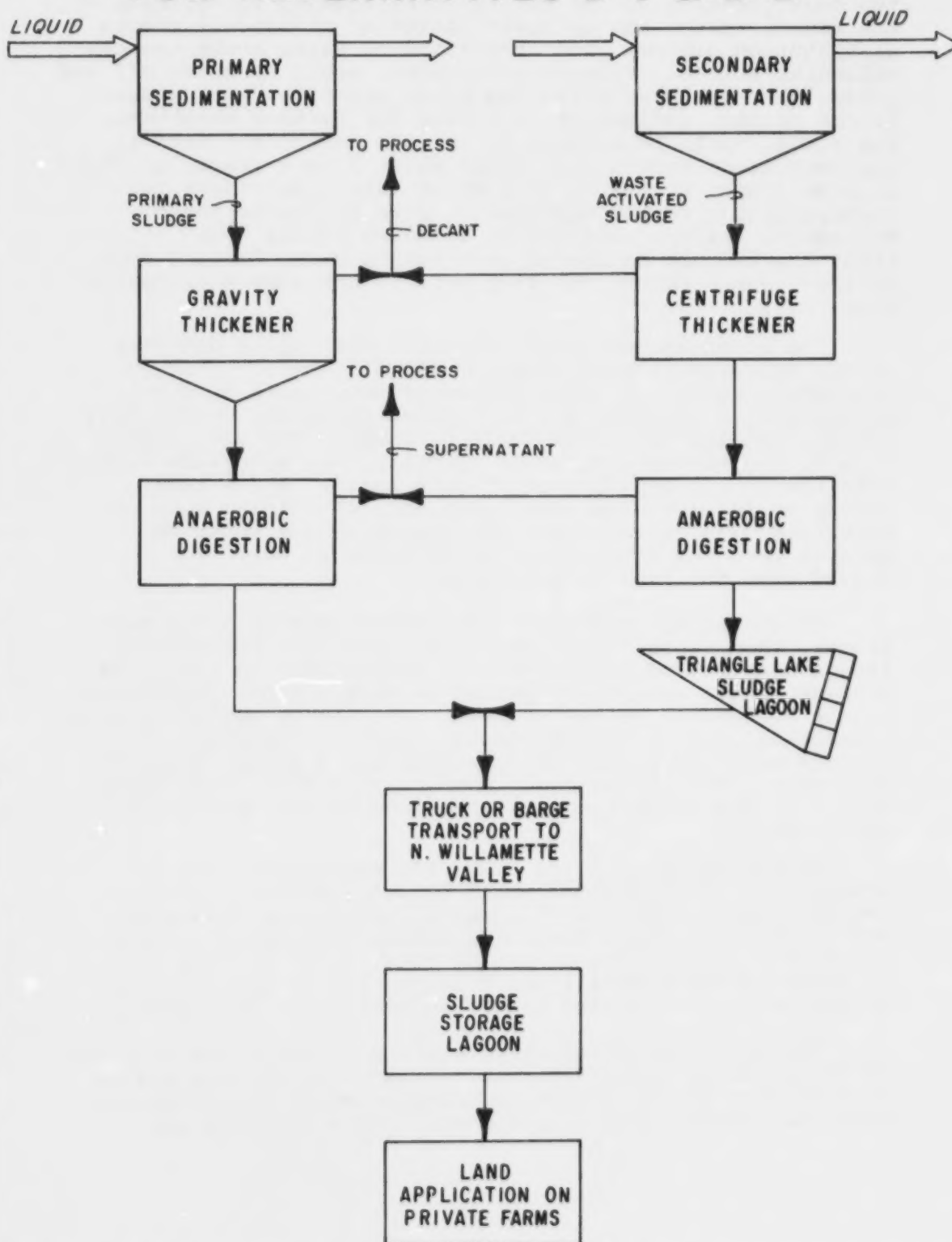
The complete marketing analysis entitled The Marketability of Heat-Dried Sewage Sludge in Portland is available upon request from the U. S. EPA, Region X office.

Alternatives D-1 and D-2, Land Application of Liquid Sludge in the Willamette Valley. These two alternatives are considered together because only the mode of transport is different. Also, because the method of ultimate sludge use is by land application, these alternatives fall into the same basic category of sludge management as Alternative A-1. The elements and facilities required for this alternative are shown schematically in Figure 13, and are described in detail herein. The system generally requires the transportation of liquid digested sludge, either by truck or barge, to the northern Willamette Valley for application on individual farms as a soil conditioner and fertilizer aid. This could be termed a system for the agricultural reuse of sludge.

The sludge collected from the primary sedimentation basins would be gravity thickened and anaerobically digested in a two-stage digestion system. The second stage permits partial thickening of the digested sludge to concentrations in the range of 7 to 8 percent solids content. The sludge from the secondary digesters is either pumped to the barge loading dock on the Oregon Slough for loading into barges or it goes directly into tank trucks for transport to the distribution center.

The waste-activated sludge collected from the secondary sedimentation basins would be thickened by air flotation units and anaerobically digested in a completely separate, two-stage digestion system. Because the digested waste-activated sludge does not settle and thicken in the secondary digester, this digested sludge would be pumped to the sludge storage lagoon where thickening would occur.

FIGURE 13
**SCHEMATIC DIAGRAM
FOR ALTERNATIVES D-1 & D-2**



The Triangle Lake Sludge Lagoon will be renovated by a thorough cleaning out of the existing sludge, enlargement of the lagoon system and by installation of additional sludge distribution piping. The free-standing water above the consolidated solids, called supernatants, would be drawn off and passed through three polishing ponds prior to being pumped to the primary sedimentation basins for further treatment. The sludge would be allowed to thicken and concentrate in the renovated lagoon, and, after about 3 to 4 years, it would also be pumped to the barge dock or into tank trucks for transportation to the application site in the northern Willamette Valley. Similarly, digested sludge from Tryon Creek would be loaded at a nearby barge loading dock, or into tanker trucks for transport to the same application site.

The river barges would transport the liquid digested sludge approximately 27 miles up the Willamette River to Clackamas County. A barge unloading dock would be constructed at a location 1/4 to 2 miles above the Oregon City Locks. The liquid sludge would be pumped from the barges to a sludge storage lagoon or directly into specially designed tank trucks for application on farm lands. These tank trucks would have wide wheels for ease of driving onto privately owned farmlands. The liquid sludge would be sprayed onto the farm lands, after which it would be disced into the land by the farmer.

If the sludge transport is accomplished by large tank trucks, then these trucks would off-load into the sludge lagoon constructed in the area of sludge application. The storage lagoon would be required because weather conditions in the Willamette Valley are such that sludge application is impractical during the wet winter months. Therefore, a storage capacity period of approximately 4 months would be necessary. The lagoon would also provide additional flexibility in the scheduling and operation of the land application system.

No-Action Alternative. The EPA regulations for the preparation of an Environmental Impact Statement (EIS) require that a "No-Action" alternative also be evaluated and compared to the alternative sludge management systems being considered. The no-action alternative for the City of Portland would entail the continuation of the existing sludge management system described earlier in this section.

The no-action alternative would be categorized in terms of the existing basic alternative sludge management system because most of the sludge is transported to the Rivergate area and incorporated into the soil. The elements and

facilities utilized in the existing system are shown in Figure 14 and are described below. The existing sludge handling systems generally consist of applying liquid digested sludge to Port of Portland property in the Rivergate area by means of large sprinkler "guns". The sludge is then incorporated into the soil.

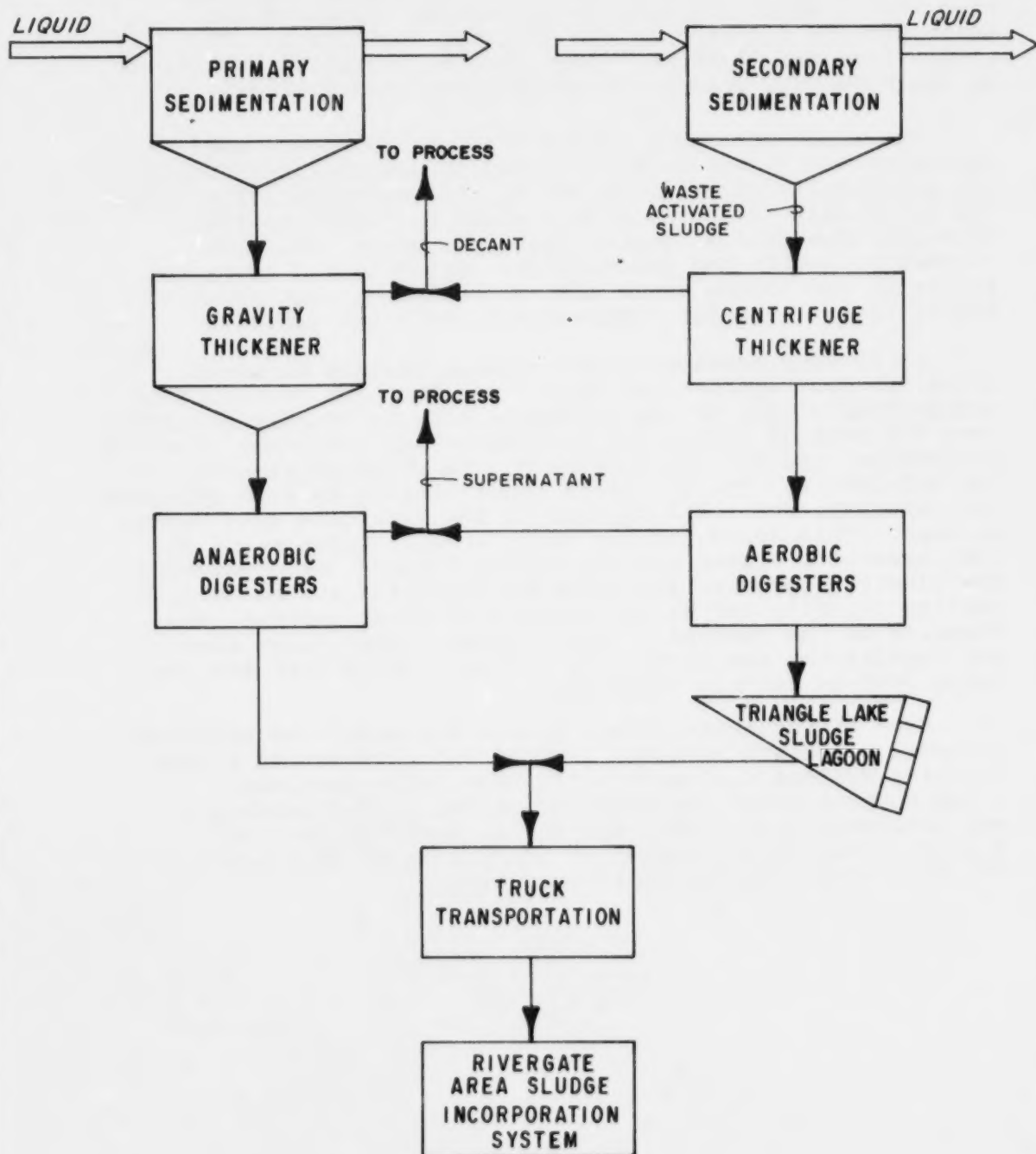
In the future, the sludge from the primary sedimentation basins would continue to be gravity thickened and anaerobically digested in the existing facilities. The sludge from the digesters would then be hauled by tank truck to the Rivergate area for incorporation into the soil.

The waste-activated sludge from the secondary sedimentation basins would be thickened by air flotation units and aerobically digested in two of the unused aeration tanks. The aerobically digested sludge would be pumped to the Triangle Lake Sludge Lagoon, where the sludge would be allowed to settle and consolidate. After 3 or 4 years the sludge in the lagoon would also be hauled by tank truck to the Rivergate area for incorporation into the ground.

As already mentioned, the existing sludge disposal sites are fast approaching capacity. The time available to accommodate sludge at the Rivergate site is totally dependent upon the rate of industrial development in the area. Current projections are for the Rivergate site to be at capacity by the mid-1980's. The St. Johns landfill site is also approaching capacity, but could be used if the Rivergate site cannot be used. This would require start-up and operation of the heat treatment system and the vacuum filters for dewatering the sludge. However, the existing digestion system is also nearing capacity and as the wastewater flows increase the capacity may be reached sooner. These higher flows also may require the use of the two aeration tanks that are now being used as aerobic digesters.

Even if wastewater flows do not increase, the existing disposal sites are severely limited and alternative sludge handling systems will eventually have to be developed. Since several years are required to design and construct new treatment facilities, the solids handling facility expansion should be started at least 4 to 5 years prior to the date scheduled for their operation.

FIGURE 14
**SCHEMATIC DIAGRAM
FOR THE NO-ACTION ALTERNATIVE**



ANALYSIS OF THE ENVIRONMENTAL IMPACTS OF THE ALTERNATIVES

Introduction

This section of the EIS identifies and discusses the environmental, social and economic impacts of four alternative plans (including no-action) for the transport and disposal of sewage sludge from the City of Portland's Columbia Boulevard sewage treatment facility. The impacts discussed include primary (direct) effects, the immediate results of an action, and the secondary (indirect) effects, the consequences of direct effects. The time frame of the impact (long- or short-term) is described wherever possible. Measures (sometimes in the form of regulations or guidelines), which could mitigate (reduce in magnitude) or avoid an adverse effect, are also identified.

The long-term impact section of this chapter is organized into several subsections based on the three phases of the project, sludge processing, sludge transport and storage and disposal.

The short-term (construction) impacts section deals with all phases of the project since such impacts can be commonly dealt with from the standpoint of mitigation.

Short-Term Impacts

Short-term impacts, as the name implies, have a short but finite period of impact, i.e., usually from the inception of construction until completion of the physical structures of the project. Such impacts can usually be effectively mitigated. Short-term impacts and common mitigation measures are presented in Table 18.

Long-Term Impacts - Sludge Processing

The processing of sewage sludge at the Columbia Boulevard STP represents a common operation among the four alternatives considered in this impact analysis. All of the alternatives depend upon the existing anaerobic digestion (primary and waste-activated sludge) and sludge treatment to produce a sludge product suitable for either disposal as a liquid or drying before reuse. Since the processing facilities represent existing facilities (or those covered under the Phase I Negative Declaration) an analysis of the impacts of such processing will not be necessary.

Table 18

SHORT-TERM IMPACTS - PORTLAND SLUDGE DISPOSAL

The direct short-term impacts of this project are related to construction activities. These impacts are relatively minor in effect and magnitude and in most cases the adverse impact can be easily mitigated. The impacts considered, their mitigation and our judgement of the relative positive or negative merits are given in the following matrix.

Short-term Impacts	Pipeline Construction	Dock Construction	Storage-facilities Construction	Alternatives				Recommended Mitigation Measures
				A	C	D	No-action	
Construction-related traffic	x	x	x	-	-	A	o	Barricades and flagmen should be posted as necessary to guide traffic through construction zones;
Disruption of through and local traffic	x		x	-	-	A	o	residents in area should be notified as to location, nature and duration of construction.
Dust	x	x	x	-	-	-	o	Keep soil wetted down in construction area.
Employment	x	x	x	B	B	B	-	None necessary.
Turbidity and disturbance of fish life	x	x		A	o	A	o	Construction should occur during low flow periods (late summer) and when anadromous fish populations would be least affected.
Noise	x	x	x	-	-	-	-	All equipment should have mufflers, properly installed and maintained. Construction activities should be limited to daylight hours.
Economic activity	x	x	x	B	B	B	-	None necessary.
Aesthetics	x	x	x	-	-	-	o	Equipment should be stored in a designated area. All litter should be picked up. Fence or otherwise screen construction maintenance area.
Soil erosion	x	x	x	A	-	A	o	If possible, construction should be done during the drier months of the year. After construction, exposed soil areas should be reseeded using grasses native to the area.
Disruption of benthic habitat		x		A	-	A	o	Limit the area of disturbance to the immediate dock location.
Safety hazard	x	x	x	-	-	-	o	All open trenches should be covered or fenced at the end of each work day. All construction equipment should be secured against unauthorized use.
Aerial pollutants	x	x	x	-	-	-	o	All vehicles and equipment should be fitted with appropriate pollution control devices that are properly maintained.
Disruption of wildlife	x			A	o	A	o	Vegetation stripping for the pipelines should occur during the late summer or fall months when nesting birds are not present.
Temporary loss of vegetation	x			A	o	A	o	Replant after construction or allow for natural regrowth of shrubs and trees. Vegetation adjacent to pipelines should be flagged or fenced to keep vegetative destruction to a minimum.

B = beneficial impact
- = minor adverse impact

A = moderate adverse impact
o = no impact

However, Alternative C (local reuse of sludge) represents an alternative that requires sludge processing beyond existing or proposed operations under Phase I. Two sludge drying processes are identified for consideration. The B.E.S.T. process employs the use of an industrial solvent (triethylamine) and heating and cooling to produce a dry, reportedly pathogen-free sludge product. The Carver-Greenfield process is a dehydration technique involving oil emersion. The following section discusses the impacts associated with the B.E.S.T. and Carver-Greenfield processes prior to the sludge transport and disposal.

Energy Use

The B.E.S.T. process requires both steam and electrical energy, but it generates an oil which can be reclaimed and used to produce a portion of the steam. Steam is required primarily for evaporation of the extraction solvent (triethylamine) from the sludge and for drying the sludge. Electrical energy powers the various motors utilized in the process, as well as the process controls and instrumentation.

Steam energy requirements are 4,775,000 BTU/ton of sludge, which, assuming an 85 percent conversion efficiency from natural gas to steam, is equivalent to 5,617,650 BTU of natural gas. Estimates indicate that over 99 percent of the steam required can be produced from digester gas and oil reclaimed during the drying process. Less than 1 percent of the energy requirement for steam would come from natural gas.

Electrical energy requirements for the B.E.S.T. process are estimated to be 375 kw-hr/ton of input sludge. Dewatering, which is a pretreatment operation to the B.E.S.T. process, would require an additional 9.6 kw-hr/ton of sludge, for a total electrical energy requirement of 422 kw-hr/ton of input sludge.

The Carver-Greenfield process has an electrical energy input of 139 kw-hr/ton of sludge, on the basis of an input of sludge having 20 percent dry solids. The higher the water content, the higher the electrical energy requirement. Fuel for heating amounts to 3.3 million BTU/ton of dry solids. The oil extracted from the sludge is used as a fuel. Heat in excess of process needs is then available from the dry sludge if a use for that heat can be identified and economically exploited. The net combined energy requirement is 1 to 2 million BTU/ton (San Francisco Bay Region Wastewater Solids Study, 1977).

Chemical Use

In addition to the extraction solvent (triethylamine), the B.E.S.T. process requires either potassium hydroxide, calcium hydroxide or sodium hydroxide for pH adjustment and an antifoaming agent. Expected chemical requirements are shown in the following table:

Triethylamine (TEA) is a tertiary alkylamine classified as stable but flammable. Acute toxicity bioassays using the California stickleback indicate a TL_m (50 percent mortality in 8 hours) of 27 mg/liter (pH=10). At a water pH of 7.0 the TL_m ranged from 980 to 1,300 mg/liter.

Table 19

ESTIMATED CHEMICAL REQUIREMENTS FOR B.E.S.T. PROCESS

	<u>lb/ton of input sludge</u>	<u>lb/year</u>		
		<u>1980</u>	<u>1990</u>	<u>2000</u>
Triethylamine (makeup)	7	178,850	204,400	229,950
Potassium Hydroxide	19	485,450	554,800	624,150
Antifoaming Agent	2	51,000	58,400	65,700

The Carver-Greenfield process uses a light oil mixed with the sludge for dewatering. The process is essentially closed and the oil fraction is recycled by centrifugal separation of the oil from the solids, then the light oil is recycled and any recovered heavy oil is used for heating.

Air Emissions

The B.E.S.T. process is principally a closed cycle operation. The main source of odors originates with the sludge drying operation, although the exhaust air would be recycled. A condensing operation would be utilized on the dryer exhaust prior to recycling and/or venting, and this condenser would remove most of the triethylamine in the dryer exhaust. A scrubber would also be used on the dry gas prior to venting to remove any remaining triethylamine or other odors. The scrubber exhaust is also to be deodorized to eliminate any chance of odor production.

The Carver-Greenfield system is also closed and does not generate significant amounts of waste gas. Waste gases are generated from the combustion of fuel oil for heating and steam generation. Odors occurring from these processes can be removed by chemical or thermal treatment.

Recycled Water

Water removed from the sludge, plus cooling water used in the vent gas scrubber, would be recycled back to the beginning of the Columbia Boulevard treatment plant. The normal wastewater treatment process would remove any remaining triethylamine, organics or suspended solids. Due to the high pH that is maintained during B.E.S.T. processing, a pH at which most heavy metals are insoluble, there would be negligible amounts of trace heavy metals in the recycled water. The estimated amount of water to be recycled would be in the range of 1,100 gallons per ton of sludge processed, or about 88,000 gallons per day in 1990.

In the Carver-Greenfield process the initial sludge moisture is recaptured as condensate. The condensate consists of distilled water with zero suspended solids, but it contains volatile components, including oil and soluble oxygen-demanding materials (San Francisco Bay Region Wastewater Solids Study, 1977).

Process Reliability

There are no full-scale B.E.S.T. sludge processing operations from which long-term operational data can be derived. The best indicator of B.E.S.T. system process reliability on treating Portland sludge is seen in data collected during the July 25, 1977 to September 22, 1977 pilot study conducted at the Columbia Boulevard treatment plant. During this 2-month pilot study, the trailer-mounted unit was checked out and operated on three different combinations of sludge. Over the entire study, including a shakedown and the checkout, the pilot plant was on line and processing sludge over 86 percent of the time.

Although the B.E.S.T. process does utilize a "mechanically intensive" system of components, no component of the system represents new technology. Each piece of equipment is presently available and is commonly used in a wide variety of industrial operations. On this basis, there is no reason to conclude that a properly operated B.E.S.T. process would be unreliable. More maintenance time and labor will be required than in a less mechanically-intensive system, but these costs have been included in the operation and maintenance costs and do not in themselves indicate an unreliable system. It should be recognized, however, that reliability of the B.E.S.T. process would require the use of highly skilled operators.

The Carver-Greenfield process has also had a short history of pilot plant application with no full-scale experience handling sewage sludges. The reliability of the process is expected to be fair since the components are comparable to those used for mineral and chemical wastes. The Los Angeles/Orange County Metropolitan Area (LA/OMA Project) regional program for wastewater solids management recently conducted a pilot plant study using the Carver-Greenfield process. Results of that pilot study are not now available.

Consistency of Sludge Quality

The B.E.S.T. process product is similar in both look and texture to coffee grounds. Consistency in the quality of the product will be closely correlated with B.E.S.T. process reliability. The product quality should be sufficiently consistent to allow intended uses to be satisfactorily met.

As with the B.E.S.T. product, the Carver-Greenfield process will produce a very dry product, which may cause dust problems (San Francisco Bay Region Wastewater Solids Study, 1977).

Material Requirements

Because the B.E.S.T. process is mechanically intensive, it will require such maintenance material items as valves, fittings, instrumentation, pumps, and other items that periodically wear out. The manufacturer estimates these items will cost no more than 3 percent per year of his original cost. The 3 percent figure is based upon the system being maintained in a condition similar to that of a new system.

The Carver-Greenfield process is also mechanically intensive. Materials selected for construction of equipment must be suitable to handle sewage sludges and corrosive ammonia fumes.

Long-Term Impacts - Sludge Conveyance

Barge Transport

A tank barge could be utilized to transport liquid sludge on the Columbia or Willamette River. Tank barges utilized for conveyance of liquid material on the Columbia River are typically 242 feet long, 42 feet wide, weigh 550 to 600 tons when empty,

and have a fully loaded draft of 13 feet and a carrying capacity of 500,000 gallons (3,200 tons). The tank barge contains 8 to 10 compartments for liquid storage with buoy compartments in the bow and stern. Tank barges utilized for conveyance on the Willamette River through the Oregon City lock are 146 feet long, 34 feet wide, have a carrying capacity of 210,000 gallons (1,400 tons) and a 5- to 8-foot draft.

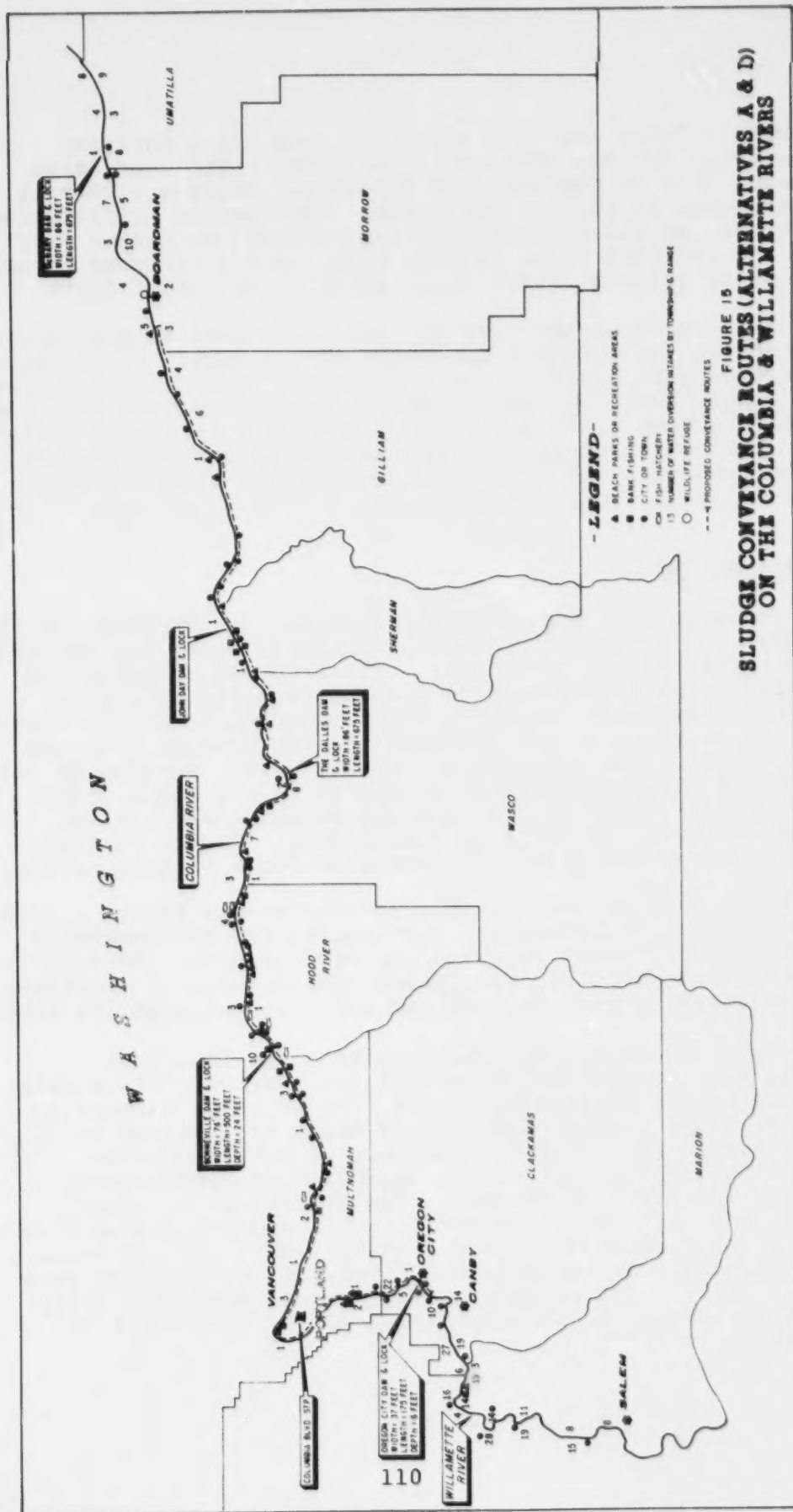
Twin-screw pusher tugs are regularly used to push barges upstream on the Columbia and Willamette Rivers. On the Columbia River tugs with 1,000 to 3,600 horsepower push 1 to 3 barges in a single tow. On the Willamette River tugs with horsepower ratings between 1,200 and 1,500 push 1 to 2 barges in a single tow. Accidents involving tugs and/or barges could adversely affect resources and beneficial uses of the river through the spillage of fuel and/or sludge.

Barging Routes

Conveyance of sewage sludge by barge is proposed for the Columbia and Willamette Rivers. Figure 15 shows the possible barge routes in the study area. The proposed route on the Columbia River from the barge loading facility on Oregon Slough to Threemile Canyon or Sixmile Canyon in Morrow County (156-170 nautical miles) involves the negotiation of locks at Bonneville, The Dalles and John Day Dams. Barging on the Willamette River from Oregon Slough to an off-loading dock at river-mile 28 or 29 (32 nautical miles) would involve passage through the locks at Oregon City. Figure 15 gives information on the sizes and depths of locks on both rivers.

Major uses of the Columbia and Willamette Rivers include the production of hydropower, commercial and noncommercial transportation, water supplies for agricultural, industrial, and municipal purposes, recreation, the passage of migratory fish to spawning grounds upstream and fish and wildlife habitat.

The Columbia and Willamette Rivers are important navigational routes for commercial and recreational vessels. Numerous navigational aids in the form of range markers, beacons, fixed channel markers and buoys are located on both rivers. In addition, navigational charts provide information on channel depths, locations of navigational aids and locations of hazards. The average daily vessel traffic for all vessels on the Columbia and Willamette Rivers in 1976 was 94 and 23 vessels, respectively. Of all vessels traveling daily on the Columbia River, 56 (60 percent) were barges. Only 6 (26 percent) of 23 vessels traveling daily on the Willamette River were barges (U. S. Army Corps of Engineers, 1977).



Liquid or dry cargo is transported by barge on the Columbia River 24 hours a day every day of the year. The greatest number of barges that are normally moved by pusher tug boats at a given time is three (Hickey, pers. comm.).

A navigation channel is maintained in the Columbia River between Portland and Bonneville Dam; the average channel depth is 22 feet. A minimum channel depth of 12 feet occurs at low flow in the vicinity of Government Island, northeast of Portland. Above Bonneville Dam main channel depths exceed 30 feet in most areas.

Barge movement on the Willamette River is less than on the Columbia River due to natural river characteristics. Between the mouth of the river and Ross Island the channel depth is maintained at 40 feet by the U. S. Army Corps of Engineers. Above Ross Island, the channel begins to meander and depths at several locations may drop to as low as 3 feet during low flow periods. Shallow or narrow areas in the river channel occur at river-mile 25 below the Oregon City lock and at river-mile 30, 32, 33 and 51 above the lock. Above Newberg the Willamette River is not considered navigable for most commercial vessels. In addition, the size and draft of commercial vessels traveling on the Willamette River past the Oregon City lock are limited by the size and shallowness (6 feet) of the lock (see Figure 15). As a result of these conditions barge transportation upstream of the Oregon City lock is limited to periods of high flow and barges with draft less than 6 feet. The characteristic meandering of the Willamette River limits to two the number of barges that can be moved at one time (Hassler, pers. comm.).

Potential hazards to barge transportation on the Columbia and Willamette Rivers include: 1) negotiating locks, especially Bonneville and Oregon City, which are narrow, short or shallow; 2) severe weather, with high winds and dense fog being the most hazardous; 3) obstructions in the water such as shoals, pilings, rocks, sunken and visible wrecks; 4) mechanical or structural failures; and 5) congestion in the numbers of vessels.

From 1972 to 1976 a total of 38 accidents involving barges were reported to the U. S. Coast Guard (U. S. Department of Transportation, 1977). The most common types of accidents (69 percent) involved collisions with fixed objects such as a lock, dock, or navigational aid or grounding. Other less common accidents involved collisions with moving or anchored vessels, capsizing and explosions.

The most common causes of barge accidents were inclement weather (40 percent), human error (32 percent) and structural failure (24 percent). Other minor causes of accidents were improper loading and congestion.

A total of 5 accidents reported to the U. S. Coast Guard between 1972 and 1976 involving dry cargo barges resulted in spills. One accident involving a tank barge resulted in a minor oil spill (U. S. Department of Transportation, 1977).

Another important use for Columbia and Willamette River waters is in agriculture. Approximately 135 diversions are located on the Columbia River between Portland and McNary Dam (Washington Department of Ecology, 1977 and Oregon Water Resources Department, 1978) (see Figure 15). Approximately 87 percent of these intakes in Oregon supply water for irrigation at intake rates ranging from .012 to 387.0 cfs. The remaining diversions supply water for industrial or municipal uses. The exact uses of diversion intakes in the State of Washington were not determined.

A total of 267 diversion intakes are located on the Willamette River between Portland and Salem. Nearly all (99 percent) of these intakes supply water for agricultural uses at intake rates ranging from .004 to 48.0 cfs. Four municipal intakes divert water at rates less than .04 cfs. The Willamette River also supplies water to 3 industries at rates ranging from .9 to 417.0 cfs (Oregon Water Resources Department, 1978).

Most of the water used for municipal, domestic and industrial purposes in the study area is taken from groundwater resources. Agricultural land irrigators away from the Columbia and Willamette Rivers and their tributaries also rely on groundwater supplies.

The most prevalent recreational use of the Columbia and Willamette Rivers within the study area is sport fishing. Figure 15 shows some locations where access to both rivers can be reached for bank fishing. Most fishing, however, is done from boats. In 1975 more than 51,000 recreation days were spent in fishing for steelhead and resident trout in northcentral and northeastern Oregon. In the northern Willamette Valley more than 787,000 recreation days in 1975 were spent in fishing for chinook salmon, steelhead, sturgeon, resident trout and warm-water game species (Oregon Department of Fish and Wildlife, 1977). Numerous state parks and recreational areas on both rivers provide access for fishing and other water-related uses (Figure 15).

Facilities associated with the Columbia and Willamette Rivers' fish and wildlife resources are the Bonneville, Cascade and Oxbow fish hatcheries in Oregon; the Spring Creek and Little White salmon hatcheries in Washington; the Umatilla National Wildlife Refuge, northeast of Boardman; and the fishways and fish ladders associated with each dam (Figure 15). Those fish hatcheries mentioned above release juvenile anadromous fish into the Columbia River throughout the year. Water supplies for propagation come from other surface or groundwater supplies rather than the Columbia River. Additional fish hatcheries located on tributaries to both the Columbia and Willamette Rivers contribute juvenile anadromous and resident species to the basin.

Truck Transport

Trucks currently being used to transport liquid sludge from Tryon Creek STP to Columbia Boulevard STP are Cummins Diesel Model NTC 350, manufactured by White Motor Corporation. The truck and trailer wheelbase is 42 feet in length, the loaded weight is 77,300 pounds and the trailer-carrying capacity is 6,000 gallons. The capital cost of each truck and trailer combination is approximately \$46,700. The truck's life expectancy is 8 years. Gas mileage is approximately 5 miles per gallon with a fully loaded truck. Truck accidents could adversely affect right-of-way and drainage resources through the spillage of fuel and liquid sludge.

Trucking Routes

Existing sludge conveyance routes from Kellogg Creek and Tryon Creek STPs to the Columbia Boulevard STP and proposed routes from Columbia Boulevard STP to the north Willamette Valley land application site are shown in Figure 16. Land use surrounding these routes is primarily high-density residential and commercial. Low-density industrial uses occur on North Columbia Boulevard east of the Columbia Boulevard STP.

Average daily traffic volumes on existing routes from Tryon Creek and Kellogg Creek STP to Columbia Boulevard STP are given in Table 20. Heavy trucks comprise approximately 3 to 9 percent of the average daily traffic volume on these routes (Oregon Department of Transportation, 1976). The total number of motor vehicle accidents at intersections of Portland city streets in 1976, on routes from Tryon Creek and Kellogg Creek STP to the Columbia Boulevard STP, were 56 and 133 respectively (Oliver, pers. comm.).

FIGURE 16
**EXISTING & PROPOSED
 SLUDGE TRUCK ROUTES**

- LEGEND -

- EXISTING ROUTES
- PROPOSED COLUMBIA BLVD. STP -
 NORTHERN WILLAMETTE VALLEY
 DISPOSAL ROUTES

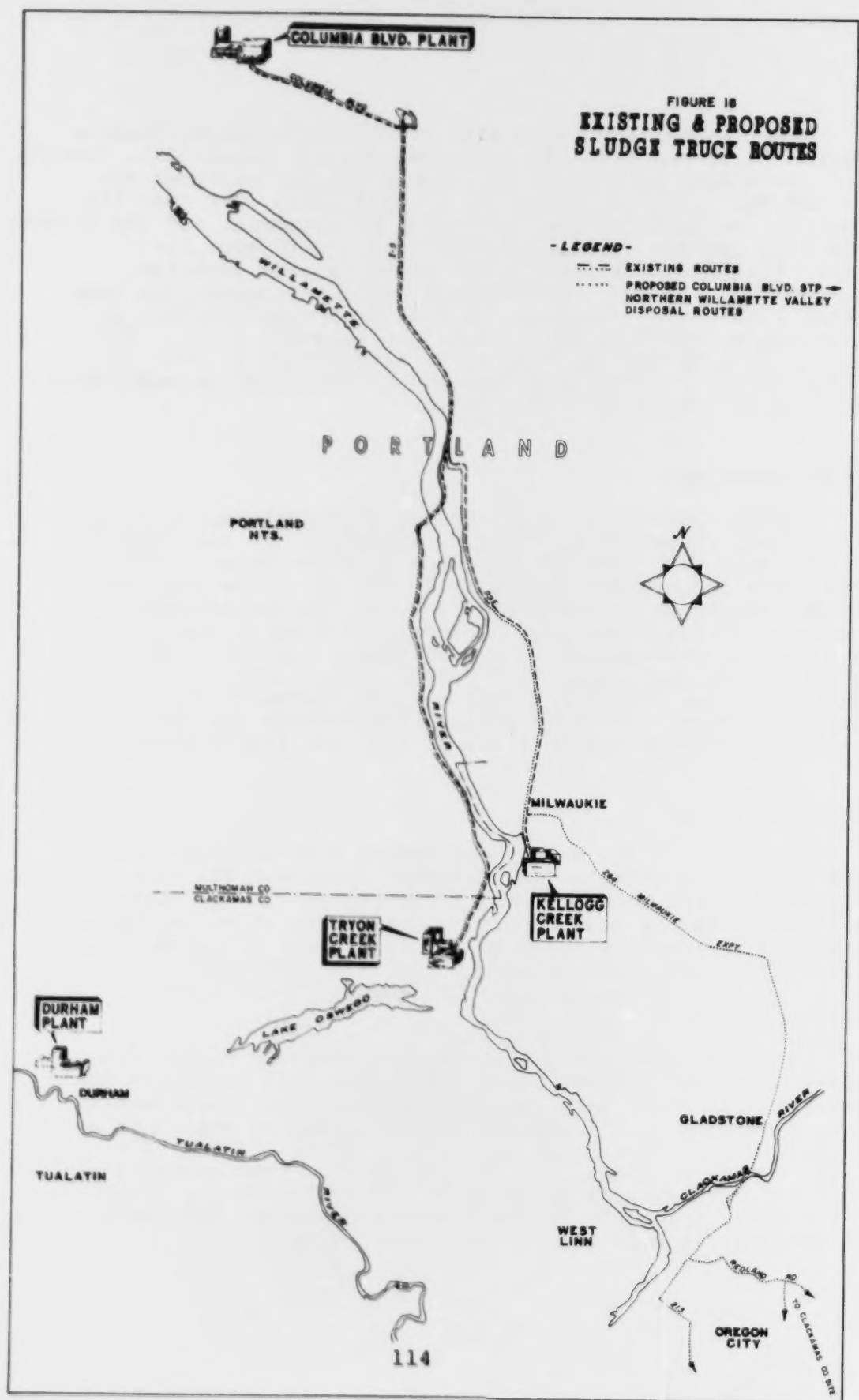


Table 20

AVERAGE DAILY TRAFFIC VOLUMES
ON EXISTING SLUDGE CONVEYANCE ROUTES, 1975

Route	ADT
Kellogg Creek to Columbia Boulevard STP	
SE. McLoughlin Boulevard	44,383
SE. Grand Avenue	25,425
SE. Morrison	22,800
Interstate 5 North	41,700
N. Columbia Boulevard	12,038
Tryon Creek to Columbia Boulevard STP	
SW. McAdam Avenue	20,610
Interstate 5 North	46,588
N. Columbia Boulevard	12,038

SOURCE: City of Portland, 1975

Existing routes from Tryon Creek and Kellogg Creek STP to the Columbia Boulevard STP are approximately 30 miles for a round trip. Three to four trips are made daily conveying liquid sludge to Columbia Boulevard STP from each STP.

Traffic Congestion and Transport Hazards

Barging. Depending on the number of barges towed per trip, by the year 2000 an approximate annual minimum of 56 and maximum of 166 trips (average 111 trips) on the Columbia River would be necessary to convey the liquid sludge to northern Morrow County. The conveyance of sludge on the Willamette River to sites in the northern Willamette Valley would require between 135 and 406 barge trips per year (average 270 trips). These trips would be confined to periods of high river flow or 8 to 9 months of the year. The increase in vessel traffic on both rivers, in addition to other such increases resulting from economic growth in the Columbia basin, would increase river traffic congestion and increase the risk for barge accidents and sludge spills.

Trucking. By the year 2000 approximately 39 round trips per day would be necessary to transport sludge produced at the Columbia Boulevard STP to sites in the northern Willamette Valley for land application. This assumes 6 percent solids content of the sludge and a truck with a 6,000-gallon capacity. This increase in heavy diesel truck traffic on city streets and highways would add to traffic congestion, particularly during peak load hours, accelerate pavement deterioration and increase the potential for truck accidents and spills.

Energy Use

Barging. By the year 2000 the annual fuel consumption to transport sludge by barge to northern Morrow County would be approximately 576,000 gallons. Assuming an equivalent fuel consumption per ton mile for pushing barges on the Willamette River the annual fuel consumption for sludge conveyance would be 157,200 gallons.

Trucking. Using an average diesel fuel consumption of 0.2 gallons per mile, approximately 170,000 gallons of diesel fuel would be consumed yearly to transport sludge to sites in the northern Willamette Valley by the year 2000.* Conveyance of sludge from the Columbia Boulevard STP to the proposed barge loading facility on Oregon Slough would consume approximately 11,400 gallons of diesel fuel per year by the year 2000.

* Note: These fuel consumption estimates are based on minimum distances from the Columbia Boulevard STP to the northern Willamette Valley. Sludge application farther south will require more fuel.

Odors

Barging. Onloading and offloading of liquid sludge should not cause an appreciable odor problem due to the enclosed pipeline conveyance systems in use from the Columbia Boulevard STP to the barge loading dock and from the offloading docks to the sludge storage areas. Any volatilization will be minor and, with effective air dispersion, should create only localized odor problems.

Barges will be enclosed, but equipped with proper ventilation equipment to prevent any accumulation of explosive methane gas. However, odor problems from ventilation should be minimal provided the sludge is properly digested.

Trucking. The tank trucks used for trucking sludge are enclosed, kept clean and should not constitute an odor problem. There is no record of odor complaints from the use of the present sludge trucking operation. The addition of more diesel-powered vehicles on the highways will increase the risk for disagreeable odors, particularly where trucks travel through heavily congested areas that require stop-and-go driving situations.

Air Emissions

Barging. Table 21 depicts the projected air emissions from barging based on a per-trip basis and on an annual basis. Annually, about 576,000 gallons of diesel fuel would be consumed in barging operations.

Projected air emissions from barging operations on the Willamette are shown in Table 22.

Trucking. Based on 1978 estimates, approximately 31 round trips per day would be necessary to dispose of sludge at the north Willamette Valley site. Each round trip will cover approximately 60 miles or 1,860 miles per day. Table 23 depicts the emissions expected daily for the years 1978 and 2000 as a result of trucking.

Sludge Loading and Unloading Facilities

Barging. Barging sludge to either Morrow County (Alternative A) or north Willamette Valley (Alternative D) will require the construction of barge docks at Oregon Slough and on either the Columbia River near Boardman or on the Willamette River above the Oregon City locks. An existing dock is located at the Port of Morrow in Boardman.

Table 21

PROJECTED EMISSIONS FROM BARGING
SEWAGE SLUDGE TO MORROW COUNTY^{1, 2}

Engine Speed	Carbon Monoxide ³ lbs/year	lbs/trip ⁴	Hydrocarbons lbs/year	lbs/trip	Nitrogen Oxides lbs/year	lbs/trip
Idle or Slow	20,529	185	8,294	75	50,734	46
Cruise	18,123	163	14,359	129	134,392	1,339
TOTALS	38,652	348	22,653	204	185,126	1,385

¹ Assumes that a 3,600-hp tug will be used and that approximately 76 percent of the barging time is at cruising speed and 24 percent at idle speed.

² See Appendix E for projected emissions based on diesel engine size - EPA, 1976.

³ Fuel consumption - 576,000 gallons annually.

⁴ Assumes 111 trips per year.

Table 22

PROJECTED EMISSIONS FROM BARGING
SEWAGE SLUDGE TO NORTH WILLAMETTE VALLEY^{1,2}

Engine Speed	Carbon Monoxide ³ lbs/year	lbs/trip ⁴	Hydrocarbons lbs/year	lbs/trip	Nitrogen Oxides lbs/year	lbs/trip
Idle or Slow	3,268	12	-	-	9,910	37
Cruise	5,812	22	-	-	61,506	302
TOTALS	9,080	34	-	-	71,416	339

¹ Assumes that a 1,580-hp tug will be used and that approximately 83 percent of the barging time is at cruising speed and 17 percent of time at idle speed.

² See Appendix E for projected emissions based on diesel engine size - EPA, 1976.

³ Fuel consumption - 157,200 gallons annually. This is based on a minimum distance from the Columbia Boulevard STP to the north Willamette Valley.

⁴ Assumes 270 trips per year.

Table 23

PROJECTED EMISSIONS FROM TRUCKING
SLUDGE FROM THE COLUMBIA BOULEVARD STP
TO NORTH WILLAMETTE VALLEY¹

Assumed Average Speed (mph)	Grams per day ²					
	Hydrocarbons		Carbon Monoxide		Nitrogen Oxides	
	1978 ³	2000 ⁴	1978	2000	1978	2000
30 mph	6,454	7,703	32,996	39,383	34,168	40,781
35 mph	5,876	7,015	27,974	33,389	34,949	41,714
40 mph	5,506	6,571	24,440	29,171	37,386	44,622

¹ See Appendix E for emission factors.

² 1 gram = 2.2046×10^{-3} pounds.

³ Assumes: 1,860 miles per day in 1978. Sludge application farther south will increase this mileage.

⁴ Assumes: 2,220 miles per day in 2000. Sludge application farther south will increase this mileage.

Long-term impacts associated with dock construction at Oregon Slough will be 1) the permanent removal of approximately 1 1/2 acres of riparian vegetation along the river, 2) filling and dredging to accommodate the docking structure and barges, 3) a change in aesthetics and land use from a presently undeveloped portion of the slough to an industrial use and 4) an intermittent increase in noise and traffic associated with barge loading.

Two of the candidate barge unloading dock sites on the Columbia River in Morrow County (Alternative A) would cause minor impacts on vegetation. Vegetation at both dock sites is sparse, consisting of sagebrush and grasses. Use of Threemile Canyon as an off-loading dock would result in the loss of an island nesting colony of Caspian terns and ring-billed gulls. Any filling and dredging at dock sites would impact existing benthic fauna and any fish species that might use the shallows (particularly juvenile fish).

Both sites represent terrestrial and aquatic habitat typical along the Columbia River. Due to the openness and sparse vegetation on the site, a dock at either Threemile or Sixmile Canyon would be a highly visible feature in the area. The Port of Morrow dock is now located in an area designated for industrial use.

An offloading dock for Alternative D could be located along a 2-mile stretch of the Willamette River above the Oregon City locks. The area is already impacted by State Highway 99E and a railroad. Major long-term impacts associated with dock construction along the Willamette River would be 1) the permanent removal of riparian vegetation, 2) an alteration of aquatic substrate at the site of the dock, 3) a permanent change in aesthetics and land use, 4) intermittent increases in turbidity levels in the Willamette River due to barging activities and 5) increases in noise and river traffic associated with the unloading facility (Figure 17).

The possibility of locating an offloading dock farther upstream (south) on the Willamette River appears limited. While the river is considered to be navigable to Newberg, much of the river from Oregon City to Newberg is shallow or narrow. A navigation channel is not maintained above the Oregon City locks and during low flow months river depths are often 3 to 5 feet. Because of these limiting conditions potential docking locations were confined to the 2-mile stretch above the Oregon City locks.

Preliminary archeological surveys conducted at each barge loading and unloading site by Oregon State University personnel, indicate that no archeological or historical resources exist at these sites. An archeologist will be on-call during actual dock construction in the event any sites are unearthed.

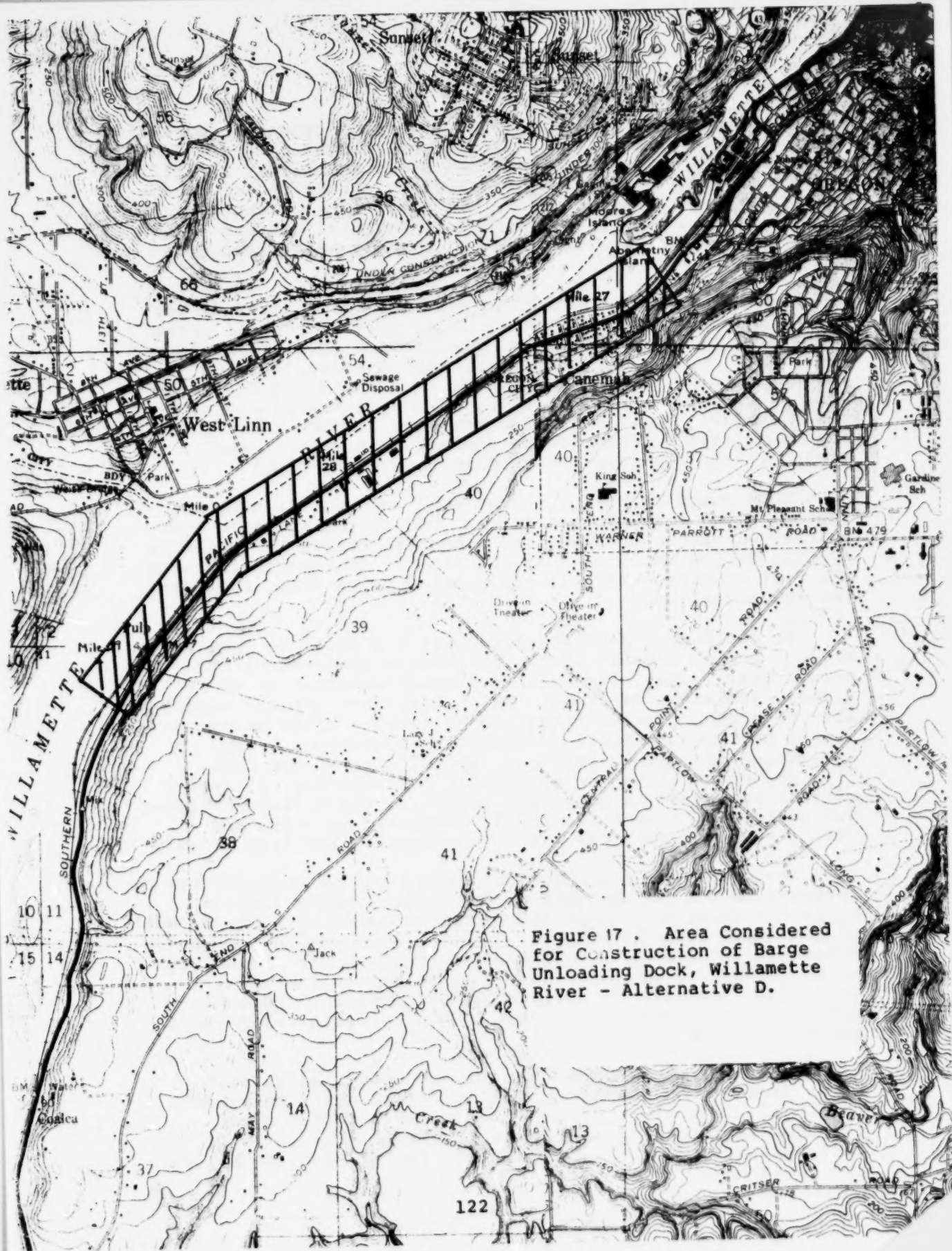


Figure 17 . Area Considered for Construction of Barge Unloading Dock, Willamette River - Alternative D.

Sludge Conveyance Reliability

Barging. Reliability of barging as a means of conveying sludge is influenced by factors such as weather, navigation hazards (shallow water, locks, etc.), mechanical reliability and labor strikes.

According to data from the U. S. Coast Guard (1976), there were 38 barge accidents on the Columbia River during the period from 1972 through 1976 for an average of about 8 accidents per year.

Poor weather is probably the major factor in the interruption of barging service. On the Columbia and Willamette Rivers weather during the winter months causes most interruptions of service. Other factors such as accidents at locks, lock failure, and the annual 2-week lock maintenance program would disrupt all river traffic temporarily.

The reliability of barging service for transport of sludge to Morrow County (Alternative A) is considered good. The Columbia River from Portland to Morrow County is used frequently for barging (56 vessels per day or 60 percent of the commercial traffic) (U. S. Corps of Engineers, 1977). Navigation channels are well marked and the river is sufficiently deep to handle large (3,600 HP tug plus three barges) barges. Some barge traffic congestion occurs on the Columbia at certain locations, particularly at the Bonneville Dam, where it usually takes 4 hours to move three barges through the short lock (Hickey, pers. comm.).

Barging on the Willamette River (Alternative D) will have a number of potential problems, all of which will affect the reliability of the project. Shallow water (particularly during summer and fall low flow periods), narrow and shallow locks at Oregon City and meanders in the river, are factors reducing the use of barges on the Willamette River (Hassler, pers. comm.).

Trucking. The reliability of truck transport is considered good so long as standby trucks are available and preventive maintenance procedures are practiced (San Francisco Bay Region Wastewater Solids Study, 1977). Some problems may be encountered with traffic congestion, safety and possible uncontrolled discharges of sewage sludge due to leaky valves or damage in transit.

Noise

Barging. Noise generated by barge tugs will be limited in impact to the onloading and offloading dock sites and a narrow strip from Portland to Morrow County (Alternative A) or just above the Oregon City locks (Alternative D). The proposed loading dock at North Portland Harbor is within an

industrially zoned area and well away from areas sensitive to noise. Tugs with diesel engines and adequate exhaust systems typically emit noise levels of approximately 75 dBA at 50 feet. Much of the noise of the diesel engines is contained within the hull or transmitted below the water line. Due to the large size of the Columbia River and the sparse population east of Portland, noise will have a minor impact.

Barge travel on the Willamette River (Alternative D) will be more frequent and closer to heavily populated areas. As a result the noise created by barging on the Willamette River would have a somewhat greater magnitude than barging on the Columbia River.

Trucking. The 300-350 hp diesel engines most commonly used in the transport of heavy materials typically emit 90 to 95 dBA at 50 feet (U. S. EPA, 1971). Any use of truck transport for Alternative D will require routing through several areas that already experience a great deal of traffic congestion and stop-and-go driving. The noise generated by the trucks is, for the most part, unavoidable. Some mitigation can be achieved by mechanical adjustments to the trucks; however, the most effective means of reducing the noise impact is by rerouting trucks through areas less sensitive to noise.

Under the no-action alternative, the impact of noise from trucks will be minor due to the lack of residential areas and the compatible industrial use nature of the Rivergate area.

Barge Spill Hazard

Transport of digested liquid sludge in barges cannot be considered to be perfectly safe, and an accidental spill of sludge into either the Columbia or Willamette could occur. Such a spill could occur if a barge ran into another object, e.g. another barge, a towboat, or a lock. Other situations which could cause a spill are grounding, sinking or an accident during loading or unloading. The principal concerns of sludge spillage relate to protection of public health, impact on the river fishery, and aesthetics.

From a public health perspective, a spill would add disease-producing organisms to the river. While the anaerobic digestion treatment used prior to barging would destroy at least 90 percent of the organisms initially present, some would still exist in the sludge during barging. The likelihood of any pathogenic organisms actually infecting a human would probably only occur following ingestion. To prevent the possibility of ingestion, an emergency program would have to be implemented immediately following a spill to warn all agencies and individuals to cease water withdrawals from the

river until the slug of contaminated water passes. Recreational beaches in the downstream vicinity of a spill would probably have to be closed for a short time. A monitoring program would also have to be established. Once the contaminated water passes, a higher than normal level of disinfection should be used for several days on any domestic water withdrawals immediately downstream from the spill, to further lessen the risk of any disease.

The impact of a spill on the river fishery could result primarily from a lowering of the dissolved oxygen concentration. A series of calculations were performed for both the Willamette and Columbia Rivers, during low flow and high temperature situations. The calculations for the Columbia River indicate that the spill of an entire barge, with dispersal of the contents in 10 minutes of river flow, could result in a minimum dissolved oxygen concentration of 6 mg/l. This minimum concentration would occur from 5.5 to 6.5 days later as the volume of affected water moves downstream.

In the Willamette River a different situation would occur. A spill during the summer months would result in severe dissolved oxygen depletion, with all dissolved oxygen in the affected water being used up within 3 days. If however, the affected water moved into the Columbia River prior to this time, a zero dissolved oxygen condition would be averted. A complete barge spill into the Willamette River during the winter months would result in about a 2 mg/l lowering of dissolved oxygen.

A spill at the Portland Harbor loading dock would present one of the worst possible spill conditions particularly during the Columbia River freshet when Willamette River flow may actually stop in the harbor due to high water levels in the Columbia River. Although calculations are difficult to make for such an estuary situation, it is estimated that a spill at the loading dock could rapidly deplete dissolved oxygen to zero if a stagnant water conditions exists. If the spill were rapidly flushed out into the main stem of the Columbia, the dissolved oxygen lowering would occur in the main stem of the river, and would be similar to the situation previously described. All such calculations are made in the conceivable worst case conditions for flow and temperature. More precise estimates would require on-site studies of current patterns in relation to river flow.

From an aesthetic standpoint, any spill would create a problem because some of the sludge would float to the surface. In addition, if dissolved oxygen is depleted, a fish kill could result.

Long-Term Impacts - Sludge Disposal

The institutional requirements and the impacts associated with the disposal of sludge vary with the means of disposal. For example, regulatory requirements for the disposal of sludge on nonagricultural land (e.g., shifting sand) or in a sanitary landfill are not necessarily the same as those for disposal on agricultural land. The impacts associated with sludge disposal in each of the four viable alternatives are different.

Water Resources

Groundwater and surface water are two natural resources that can be impacted by sludge disposal. The Oregon Department of Environmental Quality (DEQ) has issued a proposed regulation (OAR Chapter 340, Division 4, Subdivision 2, September 1977) stating that it is the responsibility of the permittee to ensure that "the disposal or application (of sludge) does not result in surface runoff, contamination of surface water or wells, or create a nuisance condition or health hazard". Furthermore, the DEQ has established guidelines governing site selection (topography, setback, and application rates) for sludge disposal (OAR Chapter 340, Division 4, Subdivision 2).

In the EPA's Technical Bulletin relating to municipal sludge management (42 CFR, No. 211), several general requirements are outlined regarding land application of sludge:

"Groundwater Protection. Projects for land application of sludges will be designed so that the permanent groundwater (groundwater which is not removed from the ground by an underdrain system or other mechanical means) in the zone of saturation (where the water is not held in the ground by capillary tension) will be protected from pollution. Consideration should be given to the extent of the project, the quality of the groundwaters, and the fact that groundwater is typically used for drinking water supply with little or no additional treatment. Also, in some areas, groundwater recharge of surface streams may be significant. Specific groundwater criteria will be developed under PL 94-580. Until such are developed under PL 94-580, criteria contained in the EPA publication Alternative Waste Management Techniques for Best Practicable Waste Treatment, EPA 430/9-75-013, should be followed."

"Controlling Surface Water Runoff. Sound engineering practice requires the control of surface runoff that may leave the site as well as that which will enter the site from contiguous properties. Controlled release of runoff from sludge application areas and effective erosion control methods must be practiced as necessary. Consideration should also be given to materials which may leach out of the sludge. Surface water criteria are to be developed under PL 94-580."

Alternative A. Alternative A (barge transport and land application in eastern Oregon) would involve the disposal of 208,250 gallons (52 dry tons) per day of liquid sludge on either agricultural land or unstable sand areas near Boardman, Oregon. At Site A (Figure 5) groundwater is greater than 6 feet below the surface (City of Portland, 1976; Portland General Electric Company, 1973). At Site B (Figure 5) (Sections 26, 27, 34 and 35) the groundwater also lies >6 feet below the surface. At Site C (Figure 5), south of the Boardman Flight Strip, the depth to groundwater is greater than 6 feet. The depth to groundwater, the type of soil and the low rainfall (approximately 7 inches per year) will make any contamination of groundwater from sludge leachate highly improbable.

The nearest known well is approximately 2,000 feet east of Site A, which is an adequate distance for protection of that well water supply (CRAG, Tech. Suppl. 8, 1977).

All three disposal sites are adjacent to intermittent waterways (Threemile Canyon and Sixmile Canyon), both of which are tributary to Lake Umatilla (Columbia River). Due to the low rainfall in the area (7 to 8 inches per year), stream flow occurs only intermittently from September through April. Heavy storms have been known to cause occasional flash flooding in both canyons (Pitney, pers. comm.). These heavy rains could cause runoff sufficient to transport the applied sludge to the intermittent streams and hence to the Columbia River. The topography of the sites is relatively uniform, with a gradual 0.8 percent slope from north to south. This slope is well within the limits of the 5 percent established by DEQ for sludge disposal. To ensure that large quantities are not washed into adjacent waterways, it may be necessary to immediately plow the sludge into the soil in the rainy season.

The U. S. Navy property and Sabre Farms have groundwater resources greater than 6 feet below the surface. No ephemeral or intermittent waterways flow through the areas. Southern portions of the Sabre Farms property have slopes up to 20 percent. The steeper slopes may be unsuitable for surface sludge application.

Drainage control and buffer zones between the waterways and the lands where sludge is applied will aid in reducing any flow of sludge into surface waters. These buffer zones may be approximately 100 to 200 feet in width.

In all likelihood, the application of sludge will be reduced during the wet season, particularly on agricultural lands. Sludge barged to Boardman and not applied during

the wet season will be stockpiled (if transported in a sludge-cake form) at the disposal site or held in lagoon storage (if transported as a liquid slurry) to be spread at a later date. This practice would greatly reduce any likelihood of sludge movement into waterways with surface runoff.

Alternative C. Alternative C (drying by B.E.S.T. or the Carver-Greenfield method and subsequent sale as a soil conditioner/fertilizer) would probably not involve a significant impact on either groundwater or surface water resources because its application would be diverse and in relatively small amounts.

Alternative D. Alternative D (barge and truck transport to the Willamette Valley) could involve the disposal of liquid sludge on agricultural lands between the Cities of Salem and Canby. Both surface and groundwater are plentiful throughout the area. Major surface waters include the Mollala River, Willamette River, Pudding River and Clackamas River.

Groundwater resources occur at variable depths throughout the North Willamette Valley. Table 1 shows the depths to groundwater in the Jory and Bornstedt soil series.

Any sludge application in the Willamette Valley will include a requirement for buffer strips between private wells (200 feet), public water supply wells (500 feet), and surface waters (100 feet for perennial water bodies, 25 feet for dry, intermittent streams) (CRAG, Tech. Suppl. 8, 1977). The use of adequate buffer zones should protect wells and surface waters from contamination.

No-Action Alternative. The no-action alternative (continuation of present means of sludge disposal) involves the disposal of sludge by the two now-in-use methods: 1) spreading and plowing into sandy soils at the Rivergate Industrial District, and 2) disposal in the Triangle Lake sludge lagoons near Columbia Slough. Disposal in the St. Johns Sanitary Landfill located at the end of North Swift Boulevard would also be a possibility.

The Rivergate Industrial District is bordered by the Columbia and Willamette Rivers and is bisected by the Columbia Slough. Bybee and Smith Lakes are located nearby.

Since 1976 the City has disposed of sludge at Rivergate. The sludge is used as a soil binder to prevent wind erosion of sandy soils. The Oregon Department of Environmental Quality approved the Rivergate disposal site with the provision that the City install wells and monitor groundwater

on a monthly schedule. Monitoring data collected during 1976 (see Table 2) indicate relatively low levels of all heavy metals except zinc. The significance of the high zinc concentrations is subject to some debate regarding sampling methods. If the values measured are fairly accurate, there may be some concern about lateral movement of contaminated water from the disposal sites to surface waters such as Smith or Bybee Lake or the Columbia River. The LD₅₀ for salmonids exposed to zinc ranges from .09 to 1.1 mg/l under laboratory conditions (Chapman, 1973). The detection levels shown for the other heavy metals (Table 2) appear inadequate for monitoring purposes.

If the no-action alternative continues it is anticipated that, depending on the rate of industrial development, 1,500 acres of land will be available for sludge disposal at the Rivergate site. That acreage is adequate to meet City needs until approximately 1983 (Nunamaker, pers. comm.).

Once the Rivergate area is no longer available as a sludge disposal site it will be necessary for the City of Portland to once again seek a place for sludge disposal.

The St. Johns landfill has an estimated remaining life of approximately 2 years (full life, 1980). The impact on groundwater of continuing to dispose of sludge at the landfill is unreported. The site has been approved by DEQ and is periodically monitored for compliance with DEQ regulations for solid waste disposal.

Odor

Stabilized sludge in slurry or dried cake form will not emit offensive odors so long as it is properly handled. It does give off a slightly "earthy" smell which is considered to be inoffensive.

Alternative A. The proposed sites for sludge application in Morrow County are situated 3 to 8 miles from the City of Boardman and 1/2 to 1 mile from Interstate 80N. When sludge is applied to the agricultural lands, odors should not be noticeable beyond the immediate vicinity. Improperly digested wastewater solids could create a significant odor problem, particularly if sludge is applied with an aerosol gun because malodorous sludge smells can be carried farther by the wind. Surface spreading and mixing with soil by injection or tilling would reduce the aerosols and volatilization.

Alternative C. The B.E.S.T. process is considered to be a closed cycle and odors would be most associated with non-condensibles being vented. The odors from the noncombustible vent gases can be handled by gas scrubbers. The water

extracting substance, triethylamine, has a strong odor but is retained within the closed system. The application of air cleansing techniques and proper operations would result in a very minor odor problem at the Columbia Boulevard plant. The conveyance of any odor to surrounding inhabited areas is considered unlikely.

The Carver-Greenfield process is also considered to be a closed cycle system. Some waste gases are generated from combustion of fuel oil. Any odors from the process can be removed by chemical or thermal treatment.

Alternative D. Disposal of sludge in the North Willamette Valley will entail the disposal of liquid sludge on a large number of relatively small private parcels. In all likelihood, the sludge will be applied by surface spreading or injection into the soil from tank-truck vehicles with over-sized tires. Subsurface injection of sludge would greatly reduce any potential odor problem. Surface spreading reduces the surface area exposed to the atmosphere and the generation of aerosols, and consequently the odor-producing potential is far less than that produced by spraying.

The major odor impact occurs immediately after application and may dissipate rapidly. Because of the relatively small size of farms in the valley the potential for odor problems is greater than in less densely inhabited areas.

No-Action Alternative. The continued disposal of sludge at Rivergate and in the St. Johns landfill could create localized odor problems. Application is now made using a large spray device that tends to enhance the volatilization of odors. Switching to another means of sludge spreading (i.e., surface spreading or injection) could greatly reduce the impact potential. At the present time, there are few human inhabitants near the Rivergate disposal area; however, with increased industrialization of the area conflicts could arise.

Aesthetics

The aesthetics of sludge disposal are, in part, dependent upon the locations of disposal areas and the methods of application.

Alternative A. The remoteness of the Morrow County sludge disposal area tends to reduce the problem of adverse aesthetic impacts.

Alternative C. There are no significant adverse aesthetic impacts associated with the B.E.S.T. or Carver-Greenfield processes because the sludge is dry and of very low odor content. The appearance of both B.E.S.T. and Carver-Greenfield solids is similar to many soil conditioners.

Alternative D. The application of sludge to agricultural lands is similar to methods used in farming operations involving heavy equipment. Such operations are familiar to agriculturists and should not be displeasing; however, aesthetic considerations are greatly dependent upon the attitude of the viewer. Buffer zones between sensitive receptors (i.e., residences, businesses and public roads) and lands where sludge is applied would reduce any possible aesthetic impacts.

No-Action Alternative. Due to the relatively limited human activity in the Rivergate area, the impact on aesthetics resulting from sludge disposal is judged to be minor. Aesthetic concerns could increase with development of the area.

Heavy Metals

Sludge from the Columbia Boulevard treatment plant contained the levels of heavy metals given in Table 24. These metals originate in industrial and domestic wastes, pavement runoff, and from groundwater infiltration into the sewer system. The major industrial contribution of heavy metals comes from 18 electroplaters, 3 galvanizers, and 6 battery manufacturers. These sources account for approximately 28 percent of the chromium, 11 percent of the nickel, 49 percent of the copper, and 29 percent of the lead in the City's sludge. The percentage of zinc and cadmium from these sources has not been determined.

Periodic monitoring of industrial sources has indicated a daily sludge discharge of 6 pounds of chromium, 5 pounds of cadmium, 42 pounds of copper, 18 pounds of nickel, and 26 pounds of zinc, (Edmonds, pers. comm.).

The EPA and Oregon Department of Environmental Quality have established guidelines and regulations regarding acceptable levels of heavy metals.

EPA has recommended that sewage sludge be analyzed "to determine nutrient values, heavy metals, and other constituents which may be economically recycled or cause environmental damage ...". "When sludges are to be applied to land, for beneficial purposes, appropriate nondomestic users of municipal wastewater treatment works should be required to pretreat their wastewaters to minimize the presence of potentially harmful heavy metals and other sludge contaminants from industrial sources" (42 CFR No. 211).

The DEQ proposed regulations and guidelines (OAR, Chapter 340, Division 4, Subdivision 2) indicate that "Prior to application on a beneficial use site, sludge should be tested for the following parameters: Pb^{++} , Cu^{++} , Zn^{++} , CR^{++} , Ni^{++} , total

Table 24

HEAVY METAL CHARACTERISTICS OF SLUDGE
FROM COLUMBIA BOULEVARD PLANT¹

Constituent	Wet Basis mg/l ²	Dry Basis % ppm ³
Cadmium	2.03	.0040 40
Chromium	12.2	.0269 269
Copper	53.8	.1149 1,149
Nickel	5.5	.0108 108
Lead	60.5	.1322 1,322
Zinc	116	.2408 2,408

¹ Averages of samples taken January-December 1977.
Total solids average 4.75 percent.

² Milligrams per liter.

³ Parts per million.

nitrogen, phosphorous, pH and total solids." DEQ has also designated allowable cumulative values for metals in soils (see Table 25). These values are the same as those established by EPA and the FDA. In order to determine the allowable values, "a representative sample of each major soil type in the region should be analyzed to determine the cation exchange capacity, conductivity, background pH and heavy metals concentrations."

Less stringent requirements regarding heavy metals loading exist where sludge will not be beneficially used (i.e., an area designated solely as a sludge disposal area and not for growing crops).

The heavy metal of greatest concern is cadmium. The EPA and DEQ have established that the cadmium content of sludge ideally should not exceed 0.5 percent of the zinc concentration and the total cadmium application per year should not exceed 2 kg/ha (1.8 lb./acre). It has been found that cadmium and zinc may be toxic to plants if present in an available form at sufficiently higher levels. Cadmium may also be accumulated by some plants and enter the human food chain (Jackson, et al., 1976). For this reason, the DEQ has proposed a regulation that no leafy vegetables should be grown on land where sludge has been applied.

According to the EPA (1976), cadmium is considered a nonessential element that can be managed so that it does not pose a hazard to plants, animals or humans. Suggestions for management include: "(1) maintain soil pH at or above 6.5; (2) grow crops which tend to exclude cadmium from the whole plant or from reproductive tissues; (3) apply low annual rates of cadmium, and use sludges which have a low cadmium concentration; and (4) grow nonedible crops" (EPA, 1976).

Heavy metals such as iron, manganese, aluminum, chromium, arsenic, selenium, antimony, lead and mercury are considered to pose relatively little hazard to crop production and plant accumulation when sludge is applied to soil because all have low solubility in slightly acid or neutral soil.

The remaining heavy metals -- copper, molybdenum, nickel and zinc -- can accumulate in plants and may pose a hazard under certain circumstances. Two of these metals -- copper and zinc -- are generally deficient in the environment and under good management practices will seldom be toxic to plants and animals. Zinc is found in Portland sludge in relatively high concentrations. These concentrations are high enough to limit the number of years sludge could be applied to an area before allowable concentrations are reached.

Table 25

MAXIMUM METAL ADDITION (POUNDS PER ACRE AND Kg/Ha)
WITH A SOIL CATION EXCHANGE CAPACITY (CEC) (meq/100g)¹

Metal	CEC less than 5		CEC 5 - 15		CEC greater than 15	
	Kg/Ha	lbs/Acre	Kg/Ha	lbs/Acre	Kg/Ha	lbs/Acre
Pb	500	446	1,000	892	2,000	1,784
Zn	250	223	500	446	1,000	892
Cu	125	111.5	250	223	500	446
Ni	50	44.5	100	89	200	178
Cd	5	4.5	10	8.9	20	17.8

Annual cadmium application rate shall not exceed two (2) kg per hectare (1.8 pounds per acre).

- ¹ CEC: Cation Exchange Capacity is defined as the extent of the ability of soil to hold positively charged cations. The CEC is expressed in milliequivalents per 100 grams of soil (meq/100g).

SOURCE: Dowdy et al., Land Application of Waste Materials, Soil Conservation Society, 1976 In: OAR Chapter 340, Division 4, Subdivision 2.

In October 1977, the EPA published a document, Municipal Sludge Management: Environmental Factors, which outlines the factors important to any land application program. Projections of allowable loading of sludge per acre (based on crop nitrogen requirements and heavy metal content of the sludge) and the life of the application areas were made based on procedures set forth in Appendix VIII of that document.

The annual allowable rate of sludge application per acre (dry tons of sludge/acre) is dictated by either the nitrogen requirement of the crop grown or the amount of cadmium in the sludge. Calculations for sludge loading for Morrow County (Alternative A) and north Willamette Valley (Alternative D) were based on nitrogen requirements for growing wheat (150 pounds per acre) and corn (120 pounds per acre), respectively. Because the levels of cadmium in Portland sludge are relatively low, it was determined that nitrogen requirements of the crops would be the factor determining the allowable annual quantity of sludge per acre.

The impact of heavy metals resulting from Portland sludge will depend upon the following factors: (1) the characteristics of the sludge, (2) properties of the soils at the alternative sites (i.e., pH, texture of soil, cation-exchange capacity, organic matter and profile characteristics), (3) groundwater and surface water locations, (4) methods and rates of application of sludge, (5) selection of crops, and (6) monitoring. The following discussion of each project alternative will relate to these factors.

Alternative A. Site-specific information for the Morrow County sludge disposal/reuse areas is presented in Table 26. Given this information, if 9.8 dry tons of sludge per acre per year were applied on the Morrow County site the projected availability of the land for this use would be approximately 10 years. An application rate of 4.6 dry tons per acre per year would extend the project use time to 20 years (Figure 18).

Maximum allowable loading to stay within the total allowable loading for zinc for a 20-year project (application site life) would be 4.6 dry tons of sludge per acre per year. Approximately 4,600 acres would be necessary. If sludge is loaded at greater than 4.6 tons per acre per year, the life of the site will be shortened even though less acreage would be necessary initially. The total acreage ultimately required would remain the same - 4,600 acres (Figure 18). This acreage requirement is an estimate based on allowable loading of heavy metals and on estimated future sludge production. The actual 20-year acreage requirement will be influenced by the actual rather than the estimated sludge quantity and character, the amount of sludge used off-site, future use and any change in regulatory requirements.

Table 26

PROJECTED LIFE, SLUDGE LOADING/ACRE
AND ACREAGE REQUIREMENTS FOR SLUDGE APPLICATION
IN MORROW COUNTY¹

Crops to be grown: wheat

Annual nitrogen requirement for wheat: 150 lbs/acre¹

Quantity of sludge needed to achieve nitrogen requirement:
4.6 tons/acre (equilibrium rate)

Cation exchange capacity: 5 to 15 meq/100 g

Allowable loading - dry tons of sludge/acre (life of project):

Lead	337 tons/acre
Zinc	93 tons/acre
Copper	97 tons/acre
Nickel	412 tons/acre
Cadmium	112 tons/acre

Most limiting heavy metal: zinc

Total amount of zinc allowed/acre: EPA and DEQ guidelines,
446 lbs/acre

Projected life of application area:

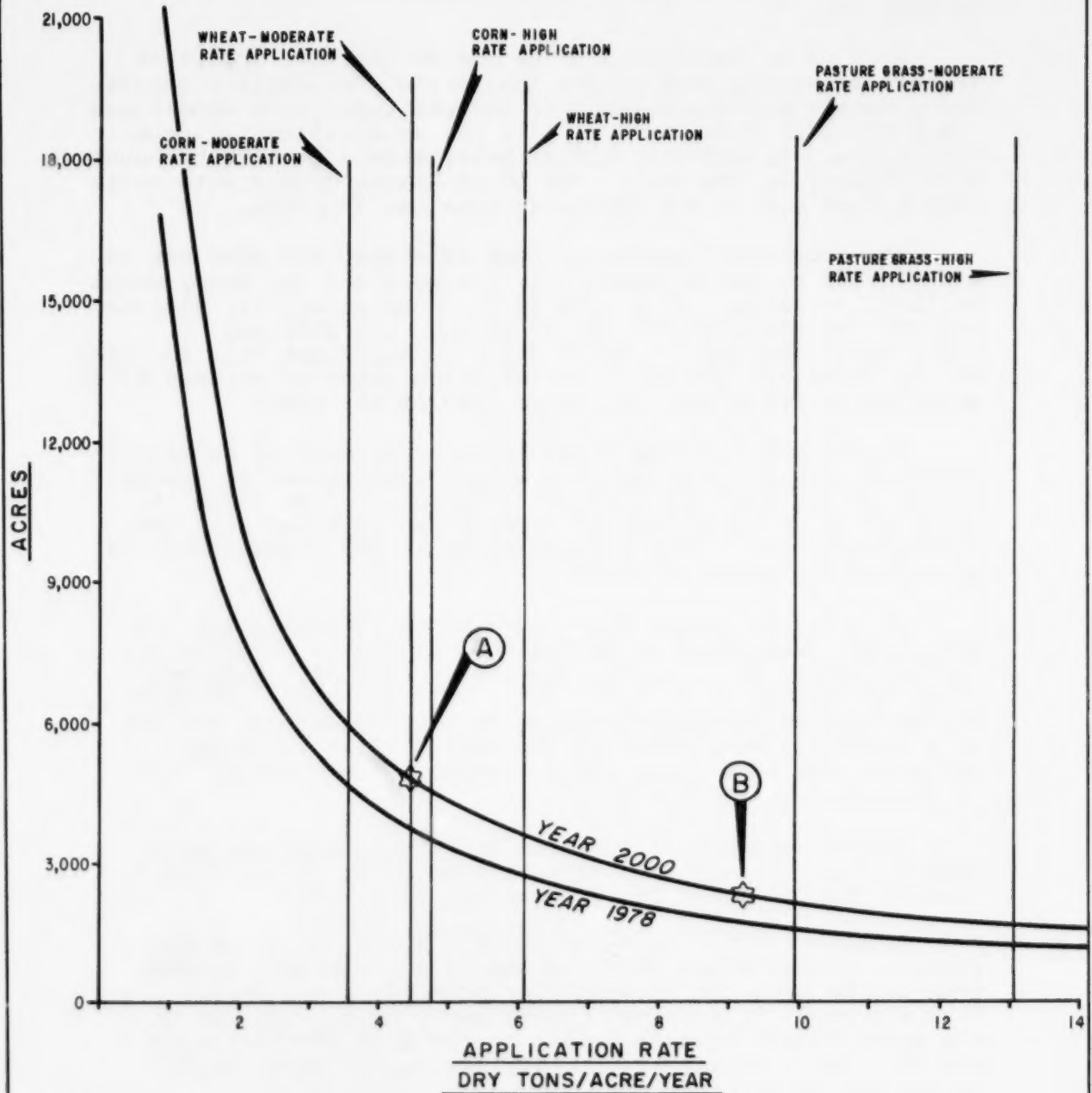
- @ application rate of 2 tons/acre/year - 47 years
- @ application rate of 4.6 tons/acre/year - 20 years
- @ application rate of >4.6 tons/acre/year - <20 years

Acreage requirements for year 2000:

- @ application rate of 2 tons/acre/year - 10,585 acres
- @ application rate of 4.6 tons/acre/year - 4,602 acres

¹ Based on EPA, 1977 Appendix VIII; O.S.U., 1972, Disposal of Municipal Wastes on Sandy Soils

FIGURE 18
PROJECTED ACREAGE REQUIREMENTS
FOR SLUDGE APPLICATION BASED ON
PROJECTED SLUDGE VOLUMES FOR
YEARS 1978 & 2000



- (A) ACREAGE REQUIREMENT FOR 20
YEAR PROJECT LIFE IN MORROW COUNTY
- (B) ACREAGE REQUIREMENT FOR 20 YEAR
PROJECT LIFE IN CLACKAMAS COUNTY

If loaded at less than 4.6 tons per acre, more acreage will be needed but the number of years sludge can be safely applied to each acre (before reaching the 93 tons per acre cumulative loading based on zinc limitation) would be increased (Figure 19).

Soil pH is considered to be one of the more important factors in established sludge application feasibility because heavy metals are typically more soluble under acid conditions (<6.5 pH) than under neutral (7.0 pH) or alkaline (>7.0 pH) conditions. In alkaline soils, heavy metals tend to be bound more tightly by the soil. The pH of Morrow County site soils ranged from 6.6 to 9.0 depending upon the location.

The acceptable number of tons of sludge per acre can be established by two methods: (1) nitrogen and (2) heavy metal application rates. If a site is to be used only for disposal and not for agricultural use of sludge, the nitrogen or heavy metal application rates would be important only in terms of the potential for pollution of groundwater or surface water supplies or its effect on future uses of the land.

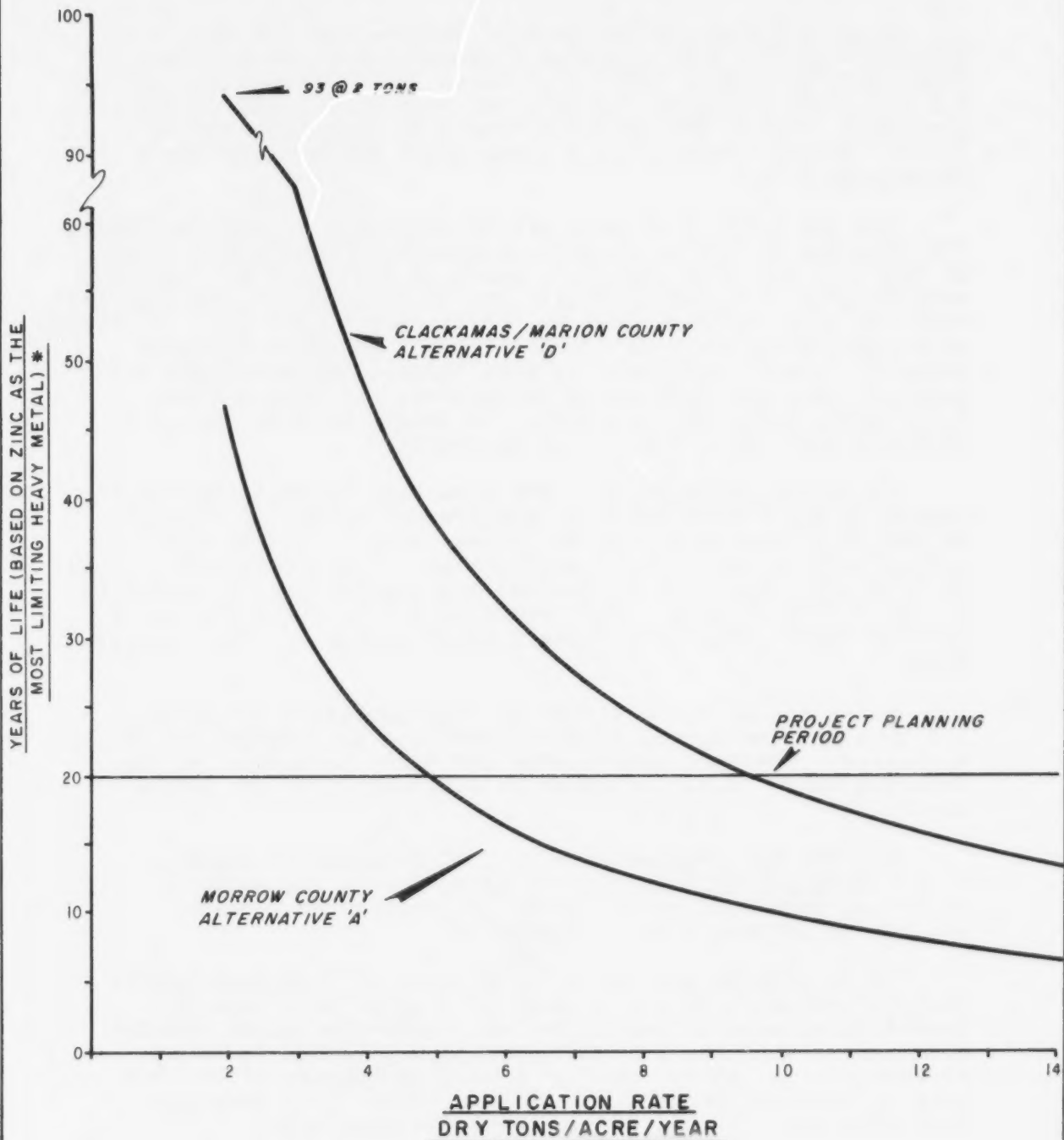
Due to the relatively low level occurrence of cadmium in Portland sludge (39 mg/kg), an annual application of approximately 23 dry tons per acre would be required to reach the limit of about 1.8 pounds of cadmium per acre per year for agricultural use. Such a quantity would add nitrogen far in excess of the needs of crops.

In order to ensure that heavy metal concentrations do not exceed background or established limits in groundwater, the Oregon DEQ will require test wells on sludge disposal sites to monitor Zn^{++} , Pb^{++} , Ni^{++} , Cd^{++} and Cu^{++} . "Sludge may be applied to disposal sites in limited amounts so long as a quarterly monitoring of the test well(s) shows no increase over background concentration of heavy-metal ions in groundwater" (DEQ, 1977).

"Test wells may be required on a beneficial use site (agricultural lands) on a case-by-case basis at the discretion of the DEQ field representative" (DEQ, 1977).

Alternative C. In Alternative C (local reuse of dry sludge), sludge would be converted to a marketable product than can be used for household or commercial purposes. Sludge processing does not remove heavy metals because of the insolubility of such metals at the high processing pH (11.5). Heavy metals are transferred to the environment in the end product.

FIGURE 19
PROJECTED YEARS OF LIFE OF SLUDGE
APPLICATION AREAS IN MORROW
& CLACKAMAS/MARION COUNTIES



SOURCES: EPA, 1977; O.S.U., 1977; O.S.U., 1972

* BASED ON HEAVY METALS ANALYSES FOR 1977 FROM THE COLUMBIA BOULEVARD S.T.P.

Because of the relatively small quantities of dried sludge used for household or commercial purposes (i.e., 50- or 100-pound bags) on any one parcel of land, heavy metal buildup in receiving soils will be low.

Alternative D. Site-specific information for the Clackamas/Marion County sludge disposal/agricultural reuse area is presented in Table 27. Given this information, if 4.6 dry tons of sludge per acre per year were applied, the projected life of the land used would be approximately 40 years. Twenty-three hundred acres would be required for a 20-year project.

Maximum loading to stay within the total allowable loading for zinc for a 20-year project (application site life) would be 9.2 tons per acre per year, which is far above the nitrogen requirements for corn or wheat, but is the approximate requirement for pasturegrass (O.S.U., 1972) (see Figure 18). If sludge were applied at the level needed to meet nitrogen requirements for wheat (moderate) or corn (high), approximately 4.6 tons per acre per year could be applied. At such a rate, 4,602 acres would be necessary. If loaded at less than 4.6 tons per acre, more land would be required.

No-Action Alternative. The no-action alternative would result in the continuation of the present method of disposal at the Rivergate area, the St. Johns landfill and in the sludge-holding lagoons (Triangle Lake). The sludge accumulated in Triangle Lake would be removed and disposed of by spreading at the Rivergate area. This would amount to the addition of 200,000 cubic yards of waste-activated sludge on the Rivergate area.

Under the existing situation, approximately 65 percent (28 tons) of the annual sludge production is disposed of at Rivergate. The remaining sludge (14 tons) is stored in the Triangle Lake. None is presently disposed of at St. Johns landfill.

The DEQ has required the City of Portland to monitor sludge disposal at Rivergate by using monitoring wells to determine levels of heavy metals in groundwater. Such monitoring is likely to continue.

If it were assumed that 1,500 acres of land were available for sludge disposal at Rivergate until 1983 (the projected final year of use of the Rivergate area under optimum conditions) and that all sludge would ultimately go to the Rivergate area, there would be a need to dispose of 102,900 tons (6 years of production) or approximately 69 tons per acre over the life of the Rivergate disposal area).

Table 27

PROJECTED LIFE, SLUDGE LOADING/ACRE
AND ACREAGE REQUIREMENTS FOR SLUDGE APPLICATION
IN THE NORTH WILLAMETTE VALLEY
(Clackamas/Marion Counties)

Crops to be grown: corn

Annual nitrogen requirement for corn: 120 lbs/acre

Quantity of sludge needed to achieve nitrogen requirement:
4.6 tons/acre

Cation exchange capacity: >15 meq/100 g

Allowable loading of dry tons of sludge/acre (life of project):

Lead	675 tons/acre
Zinc	185 tons/acre
Copper	194 tons/acre
Nickel	824 tons/acre
Cadmium	223 tons/acre

Most limiting heavy metal: zinc

Total amount of zinc allowed per acre: EPA and DEQ guidelines,
892 lbs/acre

Projected life of application area:

- @ application rate of 2 tons/acre/year - 93 years
- @ application rate of 4.6 tons/acre/year - 40 years
- @ application rate of 9.2 tons/acre/year - 20 years

Acreage requirements for year 2000:

- @ application rate of 2 tons/acre/year - 10,585 acres
- @ application rate of 4.6 tons/acre/year - 4,602 acres
- @ application rate of 9.2 tons/acre/year - 2,300 acres

Sludge Storage Lagoons

Storage lagoons will be necessary for Alternatives A and D. Wet or freezing weather conditions will make it necessary to store liquid sludge in holding ponds until it can be spread on the application areas.

Two-month storage requirements (14.1 million gallons) will probably be satisfactory at the Morrow County site. Acreage requirements for the lagoons as well as buffer and support areas will be approximately 4.5 acres. These storage ponds will be impermeable to prevent subsurface movement of liquid. The high evaporation rates in the Morrow County area will reduce the liquid in the storage lagoons considerably during the detention time.

For Alternative D, a 4-month storage facility will be necessary due to the longer period of wet weather. Acreage requirements for the lagoons and support facilities will be approximately 9 acres. This will represent a permanent loss of either agricultural land or native wildlife habitat.

Pathogens

During the normal process of stabilizing sewage sludge through aerobic and anaerobic digestion, a substantial number of pathogenic bacteria may be killed. The survival of such organisms is related to the type of process, the temperature during sludge digestion, and the retention time (Moore, et al., 1976).

Of particular importance is the survival of virus and coliforms in soil. Emonds (1976) found that the fecal coliform bacterial counts in sludge applied on forest land in Washington fell from 1.08×10^5 to 358/g during a 204-day period and then fell to 0/g at day 267. He determined that coliform die-off was most rapid in winter (1.2×10^5 to 20/g in a 162-day period). Results showed that fecal coliforms do not penetrate beyond the first 5 CM of soil and that groundwater contamination from vertical movement is unlikely.

Moore, et al. (1976) determined that soil temperature and moisture content have a significant effect on polio virus survival. Virus survival is greater when temperatures remain low (i.e., at 10 days 68 percent virus survived at 4°C [39°F]) but at warmer temperatures (30°C [86°F]) virus survival is reduced significantly (at 10 days 0.5 percent virus survival). Ideal soil moisture (i.e., 15 percent moisture content may prolong virus survival while drying 5-6 percent moisture content) significantly reduces survival.

Alternative A. Prior to land application in Morrow County, the stabilization processes will greatly reduce the number of pathogens in the sludge. The combination of digestion, stabilization and storage in the sludge lagoons will cause die-off of most pathogenic organisms. Once the stabilized sludge is applied, the soil will act as an effective removal mechanism through filtration, sorption-inactivation, and subsequent die-off. Movement of the pathogens will be restricted to the first few feet of soil.

Studies conducted in Solano County, California, indicate that pathogenic organisms in digested sludge may survive for long periods after application (over 7 months) and that the risk of infection would be greatest for farm labor personnel, but no greater than the risk to sewage treatment plant personnel (Baier, 1977).

"An evaluation of existing agricultural programs utilizing sludge reveals that no known disease outbreaks or epidemics can be traced to land that has been irrigated with stabilized sewage sludge in conjunction with a program of properly managed application procedures to prevent water contamination or direct contact with food crops normally consumed without cooking" (San Francisco Bay Region Wastewater Solids Study, 1977).

Several factors will reduce the likelihood of pathogen problems at the Morrow County site: (1) stabilized sludge will be stored for indeterminate periods at the Portland sewage plant and at the Boardman site prior to land application, and (2) sludge will be applied many months prior to the harvest of any agricultural crop upon which it will have been applied.

Alternative C. The B.E.S.T. and Carver-Greenfield processes produce 95 percent dry, pathogen-free solids suitable for land application for agricultural, ornamental (parks, highway landscaping, etc.) or disposal uses. The combination of solvent processing, cooling and heating satisfactorily kills the pathogens.

Alternative D. The impacts associated with agricultural use of sludge in the Willamette Valley will be the same as those discussed under Alternative A of this section.

No-Action Alternative. Perhaps the greatest health risk associated with the no-action alternative is to sewage treatment plant workers in transporting and applying the sludge. Direct contact of workers with sludge is the most likely transmission route for disease-causing organisms, while transmission through spray aerosols (from application) appears less likely (CRAG, 1977). With proper treatment and care in application of sludge, the risks are greatly reduced.

Nitrates

Nitrates are considered to be harmful pollutants in water supplies under certain conditions. The EPA has established an upper limit of 10 mg/l nitrate/nitrogen concentration in public water supply sources (EPA, 1972). High nitrate concentrations are frequently found in shallow wells on farms and in rural communities, most often from barnyard drainage, septic tank leachates or intense crop fertilization.

Stabilized sludge contains varying amounts of nitrogen (the percentage of nitrogen in sludge is, in part, dependent upon the source of sewage and the sludge stabilization processes). Application of sludge to agricultural land can be regulated to reduce nitrogen leaching and contamination of groundwater. The rates are established on the basis of: (1) estimated available-nitrogen content of the sludge, (2) estimated nitrogen requirements of the crops, and (3) soil testing for available nitrogen, phosphorous and potassium. More flexibility in application rates is possible where groundwater supplies are far below the surface or are not used for domestic purposes.

Alternative A. The depth to groundwater on the Morrow County sites is greater than 6 feet. No wells in the area are used for domestic drinking purposes.

Considering the great depth to groundwater and the low rainfall of the region, adverse impacts from nitrate contamination are not likely to occur.

At Site B, basaltic bedrock occurs approximately 3 feet below the surface. Continued sludge application and irrigation could lead to lateral downslope movement of water with potential outcropping along Sixmile Canyon or Threemile Canyon. More specific geologic and soils studies will be necessary to determine the acceptability of that site for sludge application.

Based on preliminary information on Sites A and C, there should be no nitrate intrusion problems.

No site-specific information has been compiled for the U. S. Navy property or Sabre Farms.

Alternative C. Since large-scale disposal of sludge on concentrated land areas is not anticipated with this alternative, nitrate contamination will not be considered a problem.

Home or commercial use of the Carver-Greenfield or B.E.S.T. products is not likely to cause excessive nitrate concentrations outside the immediate site of use.

Alternative D. Within the Alternative D study area, many parcels of land have high groundwater levels, thereby making the parcels unacceptable for sludge application. These areas were broadly defined in the CRAG Technical Supplement 8 - Sludge Management Study (Soil Suitability, Figure 4, page 30).

In the event this area is chosen for sludge application, more specific site studies will be required to establish the risk of groundwater contamination.

No-Action Alternative. Sludge has been applied on the Rivergate area since early 1976. Groundwater monitoring wells are established and periodically checked. No nitrate contamination has been recorded even though the groundwater is seasonally close to the surface and the soil type is sandy and porous.

No groundwater contamination problems have been found at the Triangle Lake sludge lagoons or at the St. Johns landfill site (Lynd, pers. comm.).

Continued heavy application of sludge at Rivergate increases the potential for groundwater contamination, contamination of nearby Bybee and Smith Lakes and the Columbia or Willamette Rivers. Nitrate contamination of surface waters typically results in greater algal blooms, dissolved oxygen fluctuations, and possible adverse affects on fish life. Aesthetic benefits typically decrease in relation to the intensity of eutrophication.

Noise

Alternative A. Noise generated from sludge disposal activities will be intermittent and of minor impact. While off-loading activities at the dock site on the Columbia River will generate local noise, the docking site will be sufficiently distant from receptors to minimize off-site noise impacts.

At the disposal site the amount of noise generated will be dependent upon the application methods employed. Spray spreading via large-nozzle sprinklers will create very low localized noise levels. Truck-spreading will be noisier but intermittent and probably limited to 7 months of the year. These activities should be no noisier than typical farming activities of the region.

Alternative C. Disposal of the B.E.S.T. or Carver-Greenfield product is likely to be by truck. If a local market is generated for the product, distribution from the Columbia Boulevard plant site to consumers will probably be made by diesel truck. Large diesel-powered trucks typically emit noise ranging from 75 to 100 dBA. Most trucking probably will be done through existing industrial or commercial areas and along major thoroughfares.

Alternative D. Noise generated by disposal of sludge in the north Willamette Valley will be of greater volume than at the Morrow County site. The small parcels of land in the north Willamette Valley will require that trucks be used for spreading. Such spreading will be confined primarily to the summer and fall months due to rainy weather and soft soil conditions during the winter and spring.

Since parcels of land are smaller in the Willamette Valley, there will be more sensitive noise receptors (i.e., residential areas) near the sludge spreading operations. Operations will be confined to daylight hours and will be of an intermittent nature. Noise levels are expected to be similar to those generated by farm equipment.

No-Action Alternative. The present areas of disposal (Rivergate, St. Johns landfill, and Triangle Lake) are within an industrial zone. Noise generated by the present method of disposal (truck mounted with a "Big Gun" sprinkler and trucking to the St. Johns landfill) is expected to be due to the absence of sensitive receptors and compatible uses in the immediate area.

Land Use and Land Planning

With any project it is important to establish its impact on existing and proposed land uses and planning. Land use planning typically involves a number of jurisdictions and may include a city (if the project is within an incorporated area); county; region (i.e., Columbia Region Association of Governments); state (Land Conservation and Development Commission), and federal (if any federal lands are involved).

Alternative A. According to the Morrow County General Plan, the three proposed sites on land leased by the Boeing Agri-Industrial Company from the State of Oregon, are designated for existing or future agricultural uses. Site A is subleased from Boeing by an agricultural group called SIMTAG. All of the 1,809 acres of Site A is in agricultural production. Crops typically rotated are wheat, alfalfa and some grass (Martin, pers. comm.). This site is projected to continue in agricultural uses.

In view of existing guidelines regarding use of sludge on cropland, the use of Site A for sludge application appears to be feasible. Alfalfa, wheat and grass all represent crops acceptable for sludge application.

Approximately 40 acres of disposal Site B is in crop production and is identified as having a future use for agriculture, either for grazing or crop production. Use of sewage sludge on this site would be compatible with that projected land use; however, physical factors peculiar to the site may limit the use of sludge (see PRESENT ENVIRONMENT section on Suitability of Land for Sludge Disposal).

Disposal Site C is presently in sagebrush and is also projected for agricultural uses.

The U. S. Navy Bombing Range is now used by Navy aircraft for practice in approach and deployment of simulated weapons. The future use of the area is uncertain.

Of the 16,000 acres on Sabre Farms property, approximately 8,900 acres are used for a wheat/potato crop rotation. Since sludge cannot be applied to land growing potatoes or other root crops, the 8,900 acres would not be available for sludge application. Crops grown on the remaining 7,100 acres would likely be suitable for sludge use.

Alternative C. The ultimate disposal method for the B.E.S.T. product is undetermined at this time. In the event that the product can be marketed locally, the sludge would be routinely applied on home gardens, for commercial agricultural use or public landscaping. Otherwise, the sludge could be stockpiled and barged to Morrow County for disposal. The land use implications of such an alternative would be the same as defined under Alternative A.

Alternative D. The land designated as a possible sludge application area in the north Willamette Valley covers nearly 400 square miles and has a variety of zoning designations (see Figure 6).

According to the CRAAG Sludge Management Study (1977), Clackamas County contains 108,000 acres of cropland, with at least 80,000 acres planted in crops considered suitable for sludge application (grain, fodder, orchards). However, not all this acreage necessarily has soil suitable for sludge application.

Preliminary analysis of the Marion County portion of the Alternative D sludge application area indicates that the average farm size is 118 acres and that much of the land is zoned for exclusive farm use.

The projected future use of those areas zoned agriculture is in 20-acre parcels. Use of sludge on those lands where the aforementioned crops are grown would be in keeping with the agricultural use of the land.

Perhaps the most significant consideration regarding a sludge application program in Clackamas/Marion Counties is the relatively small size of farms. Average farm size in Clackamas County is 72 acres and is 118 acres in Marion County. If it is assumed that the average size of all farms in the application area is 95 acres, and that by the year 2000 the City of Portland will need 10,585 acres of land (if sludge is applied at a rate of 2 tons per acre per year), it will be necessary for the city to have agreements with over 112 separate farms. If sludge is to be applied at the rate of 4.6 tons per acre per year, (4,600-acre requirement), approximately 48 farm agreements would be needed.

No-Action Alternative. The entire Rivergate area (except for parkland at the confluence of the Columbia and Willamette Rivers and Smith and Bybee Lakes) is zoned for industrial use. The present program for sludge disposal in that area is not in conflict with the present use; however, continued industrialization of the area will reduce the amount of land available for sludge disposal. Ultimately the entire area will be industrialized and sludge disposal will cease.

From the standpoint of future land use of Rivergate, sludge disposal there is at best a temporary measure.

Soils

"Once sewage sludge is applied to the land, changes in the physical structure of the soil take place, the most obvious of which is the formation of a crust of sludge on top of the soil. The crust develops because liquid sludge infiltrates the soils slowly due to the solids content and possibly the cation content. The rate of infiltration of sludge liquid will depend on the initial soil moisture content and the solids content of the sludge. The higher the soil moisture and sludge solids content, the lower is the rate of infiltration. Initially, after a sludge application, the hydraulic conductivity of sand (or infiltration rate of sludge into sand) is greater than that of silt loam soils. After a few days of successive applications of sludge, the infiltration rate is about the same regardless of soil type" (Kirkham, 1974). If the sludge is allowed to dry and is plowed in, infiltration capacity is usually maintained.

Liquid sludge has been viewed as a beneficial soil conditioner. Sludge application increases soil aggregation, changes pore spacing in clay soils, and acts as a binder to sandy soils. Additionally, anaerobically-digested sludge is known to dramatically increase the humus content of soils. Hinesly (In: Kirkham, 1974) reported that the organic carbon content of land treated with 136 dry tons per acre over a 4-year period increased from 1.2 to 2.4 percent in the surface 6 inches.

Alternative A. The soil series encompassing the proposed sludge application sites in Morrow County have predominantly sandy texture and very low organic content (<0.5 to 1.0 percent) (see Table 1). Depending on location, these soils are considered suitable for the production of wheat, grass and alfalfa.

The application of sludge on these soils will improve the physical characteristics (aggregation, water retention capacity, nutrient content, and percentage of organic matter) of the soil on which it is applied. Furthermore, it is expected that the continual application of sludge will reduce the wind erosion hazard of all soils on which it is applied.

The application of 92.6 tons of sludge per acre (the allowable loading per acre based on zinc as the most limiting metal) will constitute approximately 3 percent volume of the top 1-foot of soil. The continued addition of organic material will reduce the amount of soil now lost by wind erosion and will help to replace that which is continually lost annually.

Alternative C. The use of the Carver-Greenfield or B.E.S.T. product on agricultural lands, home gardens, landscaping, etc., will enhance the quality of the soil. The beneficial effects will be similar to those discussed in the introduction to this soils impact section.

Alternative D. Soils in the north Willamette Valley sludge application area are predominantly silty clay loam and silt loam. The organic matter content varies from 3 to 8 percent and pH from 4.5 to 6.0 (see Table 1). Sludge application will improve both aggregation and soil porosity of the clay soils (Kirkham, 1974).

The application of 185 tons per acre of sludge over the life of the application area will add approximately 292 cubic yards of material per acre, or approximately 6 percent volume of the first foot of soil.

No-Action Alternative. The continued application of sludge at Rivergate will further improve soil organic content (humus), nutrient content and act as a soil binding mechanism. The addition of the sludge will result in a more substantial vegetative cover.

Property Values

The addition of sludge to agricultural lands can be expected to increase the nutrient value, organic content and overall value of the property for agricultural uses. The use of sludge may markedly reduce the amount of commercial fertilizer necessary, and in some cases totally eliminate the need for commercial supplements.

Alternative A. Land in the vicinity of the proposed sludge application sites is valued at \$400 to \$1,000 per acre unimproved. Improved land (water, power and access available) is worth substantially more (\$1,500 per acre). Wheat, alfalfa and grass crops now grown on or near the sites are considered to be "marginally profitable" (Martin, pers. comm.).

It is anticipated that increased crop yields resulting from sludge application will increase the yield and therefore the profitability of the crops (discounting the vagaries of crop market value and demand).

Alternative C. Any agricultural land on which the Carver-Greenfield or B.E.S.T. product is applied is expected to have increased crop yields. This increased productivity could lead to some escalation in the value of land for certain agricultural crops (those to which sludge application is acceptable).

Alternative D. Impacts comparable to those defined for Alternatives A and C will occur under this alternative.

Accidents or Failures

The storage and disposal of liquid sewage sludge will not constitute a significant risk of accidents or of mechanical failures. Storage facilities will consist of holding lagoons to which sludge is pumped from the off-loading docks. Application equipment will either be stationary, employ large-orifice sprinklers or will consist of diesel trucks with tanks and spreaders.

The major threat associated with liquid sludge handling is that of a large spill, either because of storage lagoon failure or rupturing of an application truck-tank. In either case, the impact would be localized unless a transport mechanism such as water were present. While it is unlikely, if the sludge entered a water body from the storage or disposal area, oxygen depletion could occur in the water and thus jeopardize aquatic species.

Dry sludge such as that produced by the Carver-Greenfield or B.E.S.T. system would not represent a significant environmental hazard in case of accidental spillage.

Conversion or Loss of Wildlife Habitat

Alternative A. Much of Site A in Morrow County (Figure 5) is in irrigated agriculture. The circular irrigated areas typically encompass 100 to 130 acres and support crops of grains and alfalfa. Areas between the irrigated circle patterns often support remnant natural vegetation such as big sagebrush, low sagebrush, shadscale, bitterbrush and grasses such as bluebunch, wheatgrass, Idaho fescue and cheatgrass brome (Franklin, J. F. & E. T. Dryness, 1969).

A majority of Site B is in sagebrush although a small portion along the southern boundary is in agricultural use. Site C is entirely covered with natural vegetation - sagebrush, bluebunch, wheatgrass, cheatgrass brome and medusa-head wildrye.

Application of sludge would necessitate the removal of natural vegetation, probably in a way that would conform to the pattern of irrigation. The major impact on wild plants and animals will be in those areas that do not now have agricultural operations (most of Site B and all of Site C). The following acreages of sagebrush habitat are projected for conversion: Site A - 340 acres; Site B - 1,880 acres; and Site C - 3,210 acres.

Attendant wildlife species, including subsurface-dwelling and sedentary mammals and reptiles, will be lost.

The U. S. Navy property is dominated by native shrub-steppe vegetation and broad areas of barren ground (shifting sands), particularly along the northern and southeastern boundaries. In the event sludge is applied on this property it will probably be to stabilize the now barren soils. The subsequent growth of vegetation will represent an improvement of wildlife habitat.

Land on the Sabre Farms is almost exclusively agricultural. Conversion of native vegetation has already occurred.

No federal or state rare, endangered or threatened vertebrate or plant species will be impacted by the project.

Alternative C. No natural resources will be adversely affected by the Carver-Greenfield or B.E.S.T. process if sludge disposal is accomplished through local marketing. If large-scale disposal in eastern Oregon or the Willamette Valley is necessary, the land conversion impacts would be similar to those identified in Alternative A.

Alternative D. Existing lands in the north Willamette Valley where sludge would be applied are now either in cropland or pasture. Small changes in the types and amounts of natural vegetation are anticipated. Sludge can be satisfactorily spread on most of the existing cropland or pasture without conversion of land use.

No-Action Alternative. Little native vegetation is present in the Rivergate area. Most of the 1,500 acres is comprised of unstabilized sandy soil. Application of sludge should improve the soil quality to the extent that grasses and other types of vegetation can exist.

Vectors, Pests and Nuisances

Vector problems associated with sludge disposal would probably vary among the alternatives. Studies conducted in Solano County, California (San Francisco Bay Region Wastewater Solids Study, 1977), indicated that when freshly digested sludge is surface-applied to land, flies and other insects are attracted, but in small numbers when compared to undigested organic wastes.

Sludge applied in a dried form is not as attractive to insect pests. Additionally, liquid sludge that has dried on the surface does not attract insects as much as does liquid sludge.

Sludge applied too thickly on the land poses the greatest potential for vector problems. Under proper moisture conditions house flies may lay eggs in the undried sludge.

The method used for sludge application and the location chosen will influence the extent of pest or vector problems. Sludge applied in a dry form or injected below the surface will be less of an attractant to vectors than will liquid sludge applied on the surface. Likewise, sludge plowed or tilled into the soil soon after application reduces the likelihood of vector problems.

Alternative A. Under proper operating conditions, vector problems at the Morrow County site are expected to be minor. During recent years some mosquito infestation problems have occurred on irrigated areas in the Boardman area. Areas of standing water have developed from excessive irrigation and/or sealing of the upper soil layer (Runyan, pers. comm.). Although the Boardman area has high annual evaporation, constant winds and relatively sandy soils, some areas of standing water may occur on sludge application sites. Proper maintenance of the soil (i.e., tilling shortly after sludge application) should prevent any serious vector problems.

Alternative C. The end product of the B.E.S.T. or Carver-Greenfield process becomes dry and sterilized and will not support a vector problem.

Alternative D. No vector problems are foreseen with sludge applications in the northern Willamette Valley, except when sludge is applied so heavily that it does not dry completely in 4 days or less. The exact drying time to prevent fly breeding will vary with the weather conditions and the soil type. Vector problems are not associated with other sludge disposal projects in the Willamette Valley.

Crop Type and Crop Production

The U. S. EPA and Oregon DEQ have broadly defined the types of crops for which the application of sludge is acceptable or unacceptable. The acceptability of using sludge on crops is, in part, dependent upon the ultimate use of that crop (i.e., whether consumed by humans directly or used indirectly) and the susceptibility of crops to the presence of heavy metals, pathogens and parasites. In its Sludge Management Study CRAG (1977) classified crops as to suitability for sludge application. Table 28 depicts that classification.

Table 28

CROP SUITABILITY FOR SLUDGE APPLICATION

<u>Crop Type</u>	<u>Suitability</u>
Vegetables Fresh produce	Generally unsuitable because of the danger of transmitting pathogens to humans.
Processed vegetables	Generally suitable because pathogens would be destroyed during processing.
Grain	Suitable because heavy metals do not accumulate in the seed.
Fodder	Generally suitable for cattle if fodder is not harvested for 2 weeks after sludge application because pathogens would be destroyed during that period; a 2-month period is required for dairy animals.
Small fruit	Generally unsuitable because of the danger of transmitting pathogens to humans.
Orchards	Generally suitable because the direct application on trees can be prevented.

SOURCE: CRAG, 1977

The requirements for applying sludge on "food chain crops" vs. "nonfood chain crops" are significantly different. In general, annual applications may be made where food-chain crops are removed annually and the soil worked. More frequent application may be made on permanent cover crops (nonfood chain crops) such as grass seed and pasture. DEQ has established that sludge should not be applied where leafy vegetables are grown, and that "no root crops or low-growing fruit and vegetables crops which are edible when raw should be grown on land fertilized with liquid sludge for a period of 1 calendar year from date of application; exceptions would be crops to be commercially processed and which may be grown one winter season (minimum of 4 months) after application" (OAR 340, Division 4, Subdivision 2, September 29, 1977).

A number of studies have been done relating to the nutrient values of sludge and crop yields resulting from sludge use. The Oregon Agricultural Experiment Station (Oregon State University) has been studying the use of sewage sludge as a fertilizer material. Sludge has been applied to a variety of crops - corn, wheat and fescue (as a forage grass) (Jackson, et al., 1976).

The O.S.U. studies have demonstrated the attributes of using sewage sludge as a soil amendment. Most anaerobically digested sludge ranges from 1 to 15 percent total nitrogen (Portland sludge averages approximately 4 percent), 1 to 6 percent phosphorous, and 0.05 to 1 percent potassium. In general, sludge contains little nitrate-nitrogen and an ammonium-nitrogen content ranging from 1 to 4 percent on a dry weight basis. The nitrate nitrogen is readily available for plant growth; however, a large part of the ammonia portion of the sludge nitrogen (50 percent or more) may be lost by volatilization. The remaining organic nitrogen "decays" slowly over time and becomes available to plants at a later date. Because of the nitrogen "carryover" from one year to the next, it is possible after 3 or 4 years of repeated sludge application to maintain a constant nitrogen level (Table 29).

Studies conducted at the north Willamette Experimental Station indicate that crop yields after 2 years of sludge application were substantially improved, apparently because of the steady-state release of residual organic nitrogen. First-year yields (even on experimental plots receiving the highest rate of sludge application) did not reach those of plots receiving ammonium-nitrate fertilizer (Jackson, et al., 1976).

In similar studies conducted in California (Hyde, N. D.) all crops tested (field corn, dry-land pasture and irrigated pasture) had higher yields from plots receiving sludge (3 to 25 dry tons/acre/year) than from those receiving chemical

Table 29

YEARLY SEWAGE SLUDGE APPLICATIONS REQUIRED TO
PROVIDE A CONSTANT LEVEL OF AVAILABLE NITROGEN

Year	Total N ¹ kg/ha/yr	lb/ac/yr	mton/ha/yr	Sewage sludge ² ton/ac/yr
1	472	421	11.8	5.3
2	426	380	10.7	4.8
3	403	360	10.1	4.5
4	392	350	9.8	4.4
5	388	346	9.7	4.3
6	384	342	9.6	4.3

¹Total N to be added each year; calculated on basis of 25 percent of total N = $\text{NH}_4\text{-N}$ in sludge and mineralization decay rate of 0.30, 0.10, 0.05, 0.03, 0.03.

²Calculated on basis of 4 percent total N in dry sewage sludge.

SOURCE: Jackson, et al., 1976

fertilizer (field corn only) or no fertilizer (dry-land and irrigated pasture). Optimum sludge application rates for field corn were 30 dry tonnes per hectare per year (12 dry tons per acre per year) and 20 dry tonnes per hectare per year (10 dry tons per acre per year) for irrigated and dry-land pasture (Hyde, N. D.).

Few studies have been conducted dealing with the continual application of sludge and its effect on crop yield. Assuming that annual application rates are within the guidelines established for crop nitrogen requirements and heavy metals, good crop yields should continue.

Alternative A. Wheat, alfalfa and grass are the crops predominately grown in the Boardman area. Potatoes are also grown on more suitable soils to the south of the three proposed sludge application sites. Use of sludge on such crops as wheat, alfalfa and grass is considered acceptable. Potatoes are a root crop and therefore cannot be grown using sewage sludge. The annual nitrogen requirements for wheat are 75 to 100 pounds per acre; 125 pounds per acre for grass and no soil nitrogen requirement for alfalfa because it is a legume. The use of sludge for growing those crops could represent a major benefit in terms of increased productivity.

Alternative C. The Carver-Greenfield or B.E.S.T. product could be used as a soil amendment in much the same manner as liquid digested sludge. Due to the fact that the sludge is reportedly pathogen free, requirements for agricultural use may not be as stringent.

Alternative D. The north Willamette Experimental Station studies have established the value of using sludge for wheat, fescue and corn. Comparable results could be expected in the event Portland sludge is applied in the Willamette Valley.

The City of Salem has been applying sludge on 1,600 acres of agricultural land. Applications have been made on pastureland, nursery crops, berries, mint, grain, dill, orchards, hay, corn and grass seed (applications to edible crops are presumably done in accordance with DEQ regulations). On some agricultural lands, sludge has been applied for 7 years. The sludge has been used mostly as a fertilizer supplement, however, sludge alone is sufficient to fertilize grass and grain crops.

In the event this alternative is chosen, Portland sludge could be used on agricultural lands that grow those crops.

No-Action Alternative. No agricultural crops will be grown under the no-action alternative.

Financial Impact

The City of Portland will be required to pay the annual operating and maintenance costs for sludge treatment and disposal, as well as the local share of the capital costs. As part of EPA's Construction Grants program, this project is eligible for up to 75 percent EPA funding of the capital cost of the sludge handling facilities. The remaining 25 percent would represent the City of Portland's local share. This local share cost could be paid in a number of ways, but the approach which probably would be utilized is to sell bonds.

Table 30 presents an estimate of the local share costs for the year 1990, the midpoint of the period under consideration. In this estimate, it was assumed that the 25 percent local share cost was paid for by bonds, sold at an 8.5 percent interest rate and with a 20-year life. Costs were allocated between domestic and industrial users according to the tons of sludge contributed annually by each category. Many other methods could be utilized to allocate the costs, and this may or may not be the general concept adopted in the final revenue program. It does, however, indicate the general magnitude of cost per person per year.

As shown in Table 30, Alternative A-1 is the lowest in cost at \$2.65/person/year, with Alternative D-1 being the most costly at \$3.41/person/year. Alternative D-1 represents a 56 percent cost increase over Alternative A-1.

Mitigation Measures

Environmental impacts can be divided among those considered unavoidable and those which can be mitigated, i.e., those impacts whose adverse nature can be lessened or eliminated.

Many short-term impacts (those lasting for the construction period of the project) can be mitigated by using established guidelines for construction activities. Mitigation measures for short-term impacts were previously identified in Table 18.

Mitigation measures designed for long-term impacts are typically more complex and of greater importance due to the longer time period and, generally, the greater potential magnitude of their impact. Agency regulations and guidelines pertaining to the many aspects of a project may serve to reduce or eliminate the need for special mitigations due to the regulations having been established to avoid or minimize specific adverse conditions. For that reason, many of the mitigation measures outlined here relate to regulations or guideline criteria that minimize potential adverse impacts.

Table 30

LOCAL SHARE ANNUAL COSTS - YEAR 1990

Alternative	Total Capital Cost	Local Share* Capital Cost	Annual Bond Payment for Local Share**	Annual Operation and Maintenance Cost	Summation of Annual Costs	Allocation of Cost	
						Domestic Users	Total Industrial
A-1	\$16,329,000	\$4,082,250	\$431,380/yr	\$1,362,200	\$1,793,580	\$2.65/capita/yr	\$695,010/yr
C-1	15,015,500	3,753,880	396,680/yr	1,507,000	1,903,680	2.81/capita/yr	737,680/yr
D-1	17,272,600	4,318,150	456,300/yr	1,857,300	2,313,600	3.41/capita/yr	896,520/yr

*Estimated at 25% of the Total Capital Cost

**Estimated using a bonding rate of 8.5% and a bond life of 20 years

Measures to Minimize Adverse Sludge Processing Impacts

The only impacts of sludge processing dealt with in this section of the EIS relate to the Carver-Greenfield and B.E.S.T. processes. Anaerobic digesters, sludge transfer, storage, etc., were included in Phase I of this project and are either in operation or design.

Odors. Gas scrubbers should be incorporated to handle odors created by the centrifuges, triethylamine, and the noncondensable vent gases.

Noise. Centrifuges should be adequately housed and damped to reduce high noise levels typical of such equipment.

Cleanup and Disposal of Spilled Sludge. All sludge spilled during or after BEST processing should be cleaned up and stored immediately to insure that it does not enter nearby waterways or groundwater supplies.

Cleanup and Disposal of Spilled Triethylamine. Because of its toxic nature, triethylamine should be cleaned up immediately and all washdown water recycled for solvent recovery or disposal.

Health and Safety. The B.E.S.T. and Carver-Greenfield systems should be devised to warn employees of malfunctions. Contingency plans to deal with potential employee safety should be devised.

Measures to Minimize Sludge Conveyance Impacts

Barge or Truck Accidents. During 1976, ten State of Oregon agencies formed the "Oregon Accident Response System", which is designed to provide communication and line function responsibility in the event of a spill involving toxic or dangerous materials. Members of the team also notify any federal agencies having jurisdiction in the event of a spill (i.e., U. S. Coast Guard, U. S. EPA).

To ensure that the most immediate action is taken in the event of a sludge spill, either from barges or trucks, the City of Portland could establish a contingency plan linked to the Oregon Accident Response System.

It is anticipated that the liquid tank barges to be used for sludge transport on the Columbia River will contain 8 to 10 compartments for sludge in addition to bow and stern buoy compartments designed to prevent complete sinking of the barge. The tank barges were designed to carry liquid petroleum products -- materials considered to be more hazardous than liquid sewage sludge.

In the event a barge does spill its load of sludge, the City of Portland should immediately notify responsible federal, state and local authorities of the event and warn any water users downstream of the spill to terminate pumping from either the Willamette or Columbia River until the sludge load has been dispersed. Water withdrawn from the Columbia between Boardman and Portland is used exclusively for agricultural purposes while water from the Willamette is used for agriculture and industry. Municipalities using the water are limited to two on the Columbia River (Dallesport and Boardman). Four domestic intakes are located on the Willamette River between Newberg and Lake Oswego.

The DEQ proposed "regulations for handling, disposal and use of municipal sludge relating to land application" state that "the transportation of sludge from the treatment plant to the disposal or application site shall be made in such a manner as to prevent leaking or spilling the sludge onto highways, streets, roads or waterways."

Odors. In order to reduce the likelihood of odor problems during transfer and transit of sludge, all loading, offloading and conveyance systems should be "closed". At points where odors would be emitted and impact residents air scavenging systems could be installed to reduce the problem.

Archeological Resources. Preliminary field surveys at the proposed dock sites at Portland and Boardman indicate no archeological resources are present. To ensure that hidden archeological sites are not destroyed during construction, an archeologist should be on call in the event any such sites are located.

Traffic. In the event Alternative D (transport of sludge to the north Willamette Valley) is chosen, traffic congestion is likely to occur in two locations -- at the Oregon locks if barge transport is used, or in Oregon City if truck transport is used. The only mitigation possible at the Oregon locks is to enlarge facilities to handle larger barges more efficiently. Such an event is unlikely.

Routing tanker trucks via the least congested routes to the sludge application site represents the most effective means of mitigating traffic congestion impacts.

Measures to Minimize Sludge Disposal Impacts

The establishment of regulations and guidelines by the Oregon Department of Environmental Quality and the U.S. EPA, regarding the beneficial reuse or disposal of sewage sludge on land, is meant to minimize as much as possible any undesirable effects of sludge application.

The DEQ has identified a number of regulations relating to site approval, restricted use and permittee responsibility (OAR, Chapter 340, Division 4, Subdivision 2, 1977). Prior to the use of any site for sludge disposal or application the Department of Environmental Quality must approve the location. Furthermore, DEQ has the right to require a management plan for the application or disposal of the sludge. The permittee is also responsible for ensuring that the disposal or application of sludge "does not result in surface run-off, contamination of surface water or wells or create a nuisance condition or health hazard."

Guidelines established by DEQ and EPA should be utilized to the fullest when finalizing the site for sludge disposal or application for agricultural use. These guidelines represent the most up-to-date knowledge of the state-of-the-art of using sludge on the land and should be used until more definitive information becomes available.

Heavy Metals. Data indicate that several heavy metal constituents in the Portland sludge are concentrated enough to substantially limit the number of years sludge can safely be applied to agricultural land. The two most limiting constituents are zinc and cadmium. Based on 1978 sludge production and an application rate of 4.6 tons of dry sludge per acre per year, approximately 3,600 acres will be needed to handle 16,425 tons of sludge per year, and by the year 2000, 1,200 additional acres will be needed. Because of heavy metal loading, it will be necessary to abandon the application sites at 20 years and move to a new location. Lower application rates would extend the life of the sites; however, more acreage would be needed initially.

Both DEQ and EPA have recognized the need for source control (pretreatment) when heavy metal concentrations are high. The DEQ-proposed regulations and guidelines state that "in service areas where industrial processes are likely to create heavy metal concentrations higher than those found in domestic sludge, pretreatment at the source should be strongly encouraged, to extend the useful life of the application site".

The City of Portland has already exhibited the success of a source control program. Concentrations of several heavy metals have been reduced since 1975. Examples are: chromium from 365 ppm to 269 ppm; lead from 1,440 ppm to 1,322 ppm; and zinc from 3,280 ppm to 2,408 ppm (City of Portland, 1975; Edmonds, pers. comm.). Continued pretreatment programs should further reduce heavy metals in the sludge.

The U.S. EPA guidelines on municipal sludge management state: "When sludges are to be applied to land, for beneficial purposes, appropriate nondomestic users of municipal wastewater treatment works should be required to pretreat their wastewaters to minimize the presence of potentially harmful heavy metals and other sludge contaminants from industrial sources." (42 CFR, No. 211, 1977)

Overall Suitability of Land for the Application of Sludge

The suitability of land for the application of sewage sludge is dependent upon a wide variety of factors, among which are the project objectives (disposal or beneficial reuse), institutional considerations, present and projected land uses, soil types, topography, depth to groundwater, characteristics of the sludge and locations of surface water (EPA, 1977).

The project objectives may, in part, be dictated by other factors such as soil types, land use, groundwater and particularly, the chemical characteristics of the sewage sludge. If, for example, it is found that the sewage sludge contains concentrations of heavy metals judged to be too high for use on agricultural lands (or for other beneficial reuses) then the only acceptable means of sludge application on land may be disposal rather than reuse. In some cases source control of heavy metals may be in order. In the EPA document on Municipal Sludge Management: Environmental Factors, mention is made that, "when sludge is to be applied to land, for beneficial purposes, appropriate nondomestic users of municipal wastewater treatment works should be required to pretreat their wastewaters to minimize the presence of potentially harmful heavy metals and other sludge contaminants from industrial sources".

This EIS analyzes three major locations for sludge application - Morrow County near Boardman, the Rivergate Industrial area of Portland and a 400-square-mile area of the north Willamette Valley south of Oregon City.

Portland - Rivergate Industrial District

According to the 1976 SCS survey, three major soil series occur at the Rivergate Industrial area. Sludge disposal now occurs almost exclusively on the Sauvie-Rafton complex. Since the sites are used exclusively for sludge disposal and not for beneficial reuse (agriculture), the environmental requirements are not as limiting as they are for agricultural reuse. Major concerns of EPA and DEQ relative to disposal are contamination of surface and/or groundwater and the development of public nuisance conditions.

The Rivergate area has been used for sludge disposal since 1976. In July 1975, DEQ approved the use of an area "immediately east of the Fulton Terminal" for sludge disposal. Conditions of the approval were:

"1) Only liquid digested sludge shall be applied to the above described site;

"2) A minimum buffer strip of 100 feet must be left on all sides of the area;

"3) Ponding and runoff must be controlled such that nuisance conditions and/or water pollution do not occur.

"4) The sludge must be transported in vehicles approved for over-the-road travel and any spillage that occurs must be promptly cleaned and/or removed by the city.

"5) At least three monitoring wells should be provided to determine any changes that may occur in the general groundwater. The wells should be located in the buffer strip with at least one on the south side and the others spaced on the north side along the harbor. Samples should be collected at least weekly and analyzed for the following:

- a. temperature
- b. pH
- c. alkalinity
- d. total and fecal coliform
- e. heavy metals, to include Zn, Pb, Cu, Cd, Ni and Cr

The results of the monitoring should be included with the monthly operational reports for the Columbia Boulevard plant" (DEQ letter to H. Harris from L. Kramer, July 18, 1975).

The Fulton Terminal disposal area has since been abandoned (it is now a parking lot), and a new area between Kelley Point and the Fulton Terminal has been put into use. Based on the results of groundwater monitoring, it was determined by DEQ that monitoring wells would not be necessary at the new site. This action appears to conflict with DEQ proposed regulations and guidelines (OAR, Chapter 340, September 1977) that recommend:

"Test wells are required on sludge disposal sites to determine the depth and background quality of groundwater. The minimum parameters to be monitored are Zn^{++} , Pb^{++} , Ni^{++} , Cd^{++} and Cu^{++} , furthermore,

"Sludge may be applied to disposal sites in limited amounts so long as a quarterly monitoring of the test well(s) shows no increase over background concentration of heavy metal ions in groundwater."

Heavy metal concentrations reported in the earlier monitoring program are shown in Table 2; however, there are no background data with which to compare these concentrations and interpret the concentrations reported.

The continued use of the Rivergate area for sludge disposal would appear to be acceptable; however, it is likely that a well-planned monitoring and data interpretation program would be necessary. The quantities of dry sludge that can be safely applied per acre without groundwater contamination have not been determined.

Morrow County

Several areas in northcentral Oregon were examined by the City of Portland for their potential as land application sites for sludge. The landowner, lessee, or manager was contacted on three sites: the Boeing Agri-Industrial property; the U. S. Navy Bombing Range; and Sabre Farms. The Boeing Company indicated interest and a commitment in the use of sludge as a soil amendment on land currently utilized as range for grazing cattle and sheep. The U. S. Navy indicated that no long-term agreements could be made to use the Bombing Range as a disposal site; however, interest was shown in utilizing limited amounts of sludge to stabilize sandblows (Rappel, pers. comm.). Sabre Farms also expressed interest in using limited amounts of sludge on a trial basis for stabilization of sandblows, or as a soil amendment on alfalfa and pasture grass crops (Fritz, pers. comm.).

Additional areas in northcentral Oregon that were evaluated by the City of Portland, and where no contact was made with the landowners, were Blalock Canyon, a large wheat-producing area in Gilliam County, and the Irrigon area in Morrow County.

Detailed site studies have not been conducted for the Morrow County areas under consideration for the disposal of sludge. However, soil studies conducted by the USDA, Soil Conservation Service (SCS) (1972, 1976) (see Table 1) provide adequate initial information on soil types, topography, erosion hazard, depth to groundwater and other soil properties in the area. The major soil series occurring on the sites have silt loam, sandy loam or loamy fine sand texture with slight to moderate water erosion hazard and severe wind erosion hazard. These textures are considered suitable for sludge application. The cation-exchange capacity (CEC) varies from 8 to 16 meq/100g, the depth to water table is greater than 6 feet, and permeability is moderate to rapid. Slope varies from 0 to 20 percent (most of the site areas have less than 5 percent slope). No perennial waterways occur near any of the sites (the Columbia River lies approximately 2 to 3 miles north of the sites).

Existing land uses vary from one site to another. Sites A and B, on Boeing property, now support wheat, irrigated pasture grass and alfalfa. Site C is in natural sagebrush vegetation. The U. S. Navy site consists of native vegetation and barren ground. Sabre Farms support potatoes, wheat, alfalfa and pasture grasses.

All preliminary indications are that these sites could satisfactorily be used for sludge application. One site on Boeing property (Site B) may have limitations due to shallow soils (less than 6 feet of basaltic bedrock). The ultimate use of the sites for either fertilization of agricultural crops or sludge disposal will be dependent upon institutional consideration and the acceptability of sludge (in terms of heavy metals) for use on agricultural lands.

Recently, the Land Use Research Institute (Mr. George Ward) conducted studies using sewage sludge to stabilize active, windblown sand dunes on the 50,000-acre Naval Weapons System Training Facility. During 1976 the Land Use Research Institute requested that a northern portion of the bombing range be made available for sludge disposal. A decision made by the U. S. Navy in November 1976 concluded that although benefits of dune stabilization would be accomplished, it was "essential that the training facility (Naval Weapons System Training Facility, Boardman, Oregon) maintain its character as an air-to-ground target range". Such a decision precluded the use of any portion of the area for sludge disposal (Executive Correspondence, Department of the Navy to G. D. Ward, November 3, 1976).

Despite the earlier refusal by the U. S. Navy, the training facility is considered to represent a suitable location for sludge disposal. Much of the area has Koehler-Quincy soils which are loamy fine sand having 0 to 12 percent slope, high cation-exchange capacity (>15 meq/100g), high pH (6.6 to 8.4), and a groundwater table greater than 6 feet below the surface (USDA, 1972, 1976).

The feasibility of the City of Portland using the training facility for sludge disposal will be dependent upon a change of policy by the U. S. Navy regarding use of the facility and formulation of an agreement between the city and the U. S. Navy.

Clackamas County

Specific-site studies have not been conducted on the 400-square-mile sludge application area in Clackamas and Marion Counties. However, a preliminary analysis of the area was made in the

Sludge Management Study conducted by CRAG (1977). Based on an evaluation of seven soil properties, the CRAG study estimated that approximately 250,000 acres of land in Clackamas County contain suitable soils for sludge application, much of that lying within the proposed sludge application area. However, considering present land use, roads, forests, etc., the availability of land for sludge application would be considerably less than 250,000 acres. The cation-exchange capacity for the two major soil series is well above 15 meq/100g (16 to 30), meaning that the allowable heavy metal loading per acre is much greater than at the Morrow County sites. However, the soil pH is generally less than 6.5 (4.5 to 6.0) meaning that heavy metals may be more "available" to plants unless the pH is raised by using lime. Approximately 7 tons of lime per acre is required to raise the pH of soil from 6.0 to 6.5 (Sommers, N.D.). No suitability analysis was done for Marion County since the county was outside of the CRAG study area.

Existing land use is a mix of rural residential and agricultural tracts. Several areas are zoned for 1/2- to 1-acre parcels. The small size and mix of parcel sizes represents a potential constraint due to the lack of flexibility in dealing with a large number of small landowners. A determination of the size of agricultural parcels and the general availability of the lands for sludge application has not been made but will be necessary to determine the feasibility of using such areas. Due to present agricultural use of the area, it is unlikely that sludge disposal (without beneficial reuse) would be an acceptable alternative.

UNAVOIDABLE ADVERSE IMPACTS

Each of the four alternatives evaluated would create unavoidable adverse impacts. These impacts have been described on preceding pages, and mitigation measures capable of reducing the magnitude of the impacts have been suggested where appropriate. The following table summarizes the unavoidable adverse impacts of construction and operation of the four systems.

Summary of Unavoidable Adverse Impacts

Impact - Short Term	Alternatives			
	A	C	D	No-Action
<u>Construction</u>				
Construction-related traffic	X	X	X	
Disruption of local traffic	X	X	X	
Local creation of dust and/or mud	X	X	X	
Local turbidity and disturbance of fish life	X		X	
Wildlife and wildlife habitat loss	X			
Noise	X	X	X	
Aesthetics (visual disruption)	X	X	X	
Soil erosion	X	X	X	
Aerial pollutants	X	X	X	
Local disruption of wildlife	X		X	
Temporary loss of vegetation	X		X	
<u>Impact - Long Term</u>				
<u>Sludge Processing</u>				
Energy use		X		
Chemical use		X		
Air emissions		X		
<u>Sludge Conveyance</u>				
Traffic congestion and transport hazard	X	X	X	
Energy use	X	X	X	X
Odors	X	X	X	X
Air emissions	X	X	X	X
Sludge loading and unloading facilities	X		X	
Noise	X	X	X	X
<u>Sludge Disposal</u>				
Odor	X	X	X	X
Aesthetics	X		X	X
Heavy metals	X	X	X	X
Pathogens	X		X	X
Nitrates			X	X
Conversion and loss of wildlife habitat	X			
Vectors, nuisances	X		X	X
Costs to taxpayer	167 X	X	X	X

LOCAL SHORT-TERM USES OF THE
ENVIRONMENT VS. MAINTENANCE AND
ENHANCEMENT OF LONG-TERM PRODUCTIVITY

All of the alternative sludge disposal or reuse alternatives, including no action, involve tradeoffs between beneficial and adverse impacts. The alternative selected as being most appropriate is intended to achieve the maximum beneficial effect at the lowest possible environmental, social and monetary cost.

The major benefit sought by each project alternative is the solution to the problem of sewage sludge disposal for the Columbia Boulevard Sewage Treatment Plant. The present places of disposal, i.e., the Rivergate Industrial District, St. Johns landfill and Triangle Lake, are temporary, and while there is no recognized water quality or public health problem associated with the present disposal, the land area available is insufficient to meet disposal needs beyond about 1983.

Alternatives A, C and D require certain environmental trade-offs to achieve the long-term benefits sought. While all three alternatives require increased fuel (energy) for transport, Alternative C would require additional power and chemicals for sludge processing. Each of the three alternatives beneficially reuse sewage sludge as a soil conditioner/amendment and as a source of nutrients. In all cases the objectives of the City of Portland to dispose of its sewage solids are accomplished.

Because of moderate levels of some heavy metals in the sewage solids, especially zinc, the use of sludge for agricultural purposes may represent only a short-term aid to soil productivity. Such short-term enhancement can be extended by proper management, either in terms of further controlling the source of heavy metals or reducing the application rates. In the event that sludge is disposed of in Morrow County on wind-eroding sand rather than reused for agricultural purposes, the long-term productivity of what are now unusable or threatened lands could be enhanced. Shifting sand areas would be stabilized to eliminate the continual movement of sand onto productive farmlands and across roadways.

The long-term dedication of land areas for docking structures, storage lagoons and sludge disposal or agricultural application, is justified because of the limited size of the current means of disposal and the anticipation of potential adverse environmental problems to come if the Rivergate sites are overloaded.

IRREVERSIBLE AND IRRETRIEVABLE COMMITMENTS OF RESOURCES

Minor and major irreversible and irretrievable commitments of both renewable and non-renewable resources will occur if one of the proposed alternative projects is implemented. Construction will irretrievably commit mineral resources in the form of aggregate, pipe, wood; excavated, displaced and submerged soils and vegetation; and petroleum fuel sources. A considerable amount of man-hours, capital and energy resources will be required.

After a project is in operation, man-hours and chemical and energy resources will continue to be utilized for sludge processing, conveyance and disposal.

UNRESOLVED ISSUES

During the course of report preparation, it became clear that there are several key issues relative to the Portland sewage sludge disposal project. These issues were identified in the INTRODUCTION to this Draft EIS and were further discussed throughout the report. The resolutions to several of the issues are regulatory or institutional problems that must await further governmental action.

- o Review of heavy metal constituents of Portland sludge indicates moderate concentrations of zinc (2,408 mg/kg). Zinc concentrations are sufficiently high to reduce the projected life of application sites when sludge is applied at rates greater than 4.6 tons per acre per year at Morrow County and to significantly increase the area of land needed to the year 2000. Three apparent options are available to deal with this loading: 1) additional source control of those industries contributing heavily to the metal loading and 2) utilization of larger amounts of land if sludge is used for agricultural purposes and 3) disposal of sludge on a smaller area with no beneficial use and the possible long-term degradation of such land.
- o Preliminary review of test well monitoring results at the Rivergate industrial area indicated high amounts of zinc in the groundwater. No predisposal background data exist with which to compare the monitoring results. The acceptability of continued use of Rivergate as a disposal area must be reviewed and evaluated.
- o The use of Boeing agri-industry land or the U. S. Naval property in Boardman strictly for disposal of sludge (rather than for beneficial agricultural reuse) may be unacceptable to land owners and lessees in Morrow County.

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Appendix A

U. S. Environmental Protection Agency
Technical Bulletin
Municipal Sludge Management

Register
of
Proposed

WEDNESDAY, NOVEMBER 2, 1977

PART IV



**ENVIRONMENTAL
PROTECTION
AGENCY**

Municipal Sludge Management

■
**ENVIRONMENTAL
FACTORS; TECHNICAL
BULLETIN**

[6560-01]

ENVIRONMENTAL PROTECTION
AGENCY

[FRL 810-7]

MUNICIPAL SLUDGE MANAGEMENT

Environmental Factors; Technical Bulletin

On June 3, 1976, in the *FEDERAL REGISTER* (41 FR 22532), the Environmental Protection Agency published for public comment a proposed technical bulletin, "Municipal Sludge Management: Environmental Factors." The Bulletin has been prepared to assist EPA Regional Administrators in evaluating grant applications for construction of publicly owned treatment works under Section 203(a) of the Federal Water Pollution Act as amended. It also provides designers, municipal engineers and others with information for selecting a sludge management option. The Bulletin addresses only factors important to the environmental acceptability of a particular sludge management option and does so in a general manner to allow maximum flexibility.

Written comments on the proposed Technical Bulletin were invited and received from interested parties. EPA has carefully considered all comments received. All written comments are on file with the Agency, and are available for examination at the Municipal Construction Division, Office of Water Program Operations.

Many of the comments received clearly expressed concerns over the need for regulations, criteria and detailed guidelines to provide better control of sludge disposal and utilization activities. Although this Bulletin will exercise some control over the design of sludge management systems, it does not address in detail the control of operating systems. Efforts pursuant to the recently passed Resource Conservation and Recovery Act of 1976 (Pub. L. 94-580) are underway to develop specific criteria and guidelines for sludge management activities.

Comments were received from a wide variety of sources (Federal agencies, State regulatory agencies, environmental groups, municipalities/counties/cities, consultants, university extension and research groups, special interest groups and the general public). These comments indicated both support for and opposition to a number of points made in the proposed Technical Bulletin. Conflicting points of view were often noted among comments received on a particular topic, even when received from the same type of reviewer. In many cases, agreement was indicated by numerous commenters who favored or supported a certain position. Modifications were made to the document wherever there was clear and strong support for change.

The principal comments received and the responses to them are summarized below:

(a) Several comments requested that public hearings be held prior to final

publication of the Technical Bulletin. Numerous versions of the proposed document have been extensively reviewed and the comments received were carefully considered. The major issues raised were generally the same issues that were identified during the early efforts to develop this document and center on regulatory concerns. The need for specific criteria and guidelines for the control of land disposal and utilization practices was the major concern expressed in the comments. Criteria for State regulatory programs for the control of solid waste activities, including municipal sludge management, are being developed as part of implementation of the Resource Conservation and Recovery Act of 1976 (Pub. L. 94-580). Public Hearings will be conducted as part of efforts to establish criteria and guidelines under that Act.

(b) Many comments were received that indicated a need to clarify the roles of the Food and Drug Administration (FDA) and the U.S. Department of Agriculture (USDA) in the development and review of facility plans addressing sludge management. The detailed monitoring, review and approval activities by USDA and FDA for certain projects as indicated in the proposed document could lead to excessive manpower and funding requirements for these Agencies. The final version recognizes FDA as the agency which should establish recommended acceptable levels of various contaminants in human foods and animal feeds. In addition to indicating the availability of USDA assistance to municipalities, the Bulletin encourages USDA to continue to develop and provide site-specific recommendations on the best agricultural practices for use of municipal sewage sludge by farmers on privately owned lands. The objectives of such recommendations are to minimize or eliminate monitoring requirements on the farm while protecting farmland for future agricultural use, maintaining normal productivity, and assuring continued farm income. Technical assistance is a major role and will be available from FDA, various USDA extension and research offices, as well as EPA and the State Agricultural Experiment Stations.

(c) Numerous comments were received regarding the need for establishing allowable levels for heavy metals and other contaminants in sludges applied to the land. This document is not intended to be regulatory in nature, but rather to provide information on items to be considered in evaluating construction grant applications. More specific guidance on acceptable levels of contaminant additions to agricultural land from solid waste (including sludge) are planned to be developed and published under the Solid Waste Disposal Act, as amended by the Resource Conservation and Recovery Act of 1976 (Pub. L. 94-580).

In an effort to provide the most current state-of-the-art information available on the potential effects on agricultural crops and animals by heavy metals in sewage sludges applied to cropland,

EPA has recently published a report titled "Application of Sewage Sludge to Cropland: Appraisal of Potential Hazards of the Heavy Metals to Plants and Animals" prepared by the Council for Agricultural Science and Technology (EPA 430/9-76-013; November 1976). This report and others that are planned for publication in the near future will provide in-depth presentations of available information on topics of major interest and concern related to municipal sewage sludge management.

The revised Bulletin recommends that adequate testing of the sludge be undertaken to provide the user with a basis for designing and operating the system and for developing future control mechanisms. It recommends that all sludges be analyzed to determine the range of levels of heavy metals (especially Cd, Zn, Mo, Ni and Cu), persistent organic compounds (such as chlorinated pesticides, and PCB's), and other chemical or biological contaminants of concern whenever land application of sludge is proposed.

(d) Numerous comments addressed the section on "Projects of Minimal Concern." In response to these comments and other factors, this section has been rewritten to only address demonstration projects. For demonstration projects where significant resources and manpower are available for control and monitoring, it is indicated that recommendations within the Bulletin may be exceeded in an effort to investigate new approaches for sludge management. General guidance for "dedicated" utilization or disposal sites is provided in other sections.

(e) Numerous comments expressed the need for additional detailed information to be included in the Bulletin covering each utilization and disposal option. The final Bulletin has been maintained as short and precise as possible while providing general guidance to the Construction Grants Program on those environmental factors to consider when reviewing proposed municipal sewage sludge management projects. It was not written as a regulatory document or design manual. Current pertinent regulations are either cited or referenced. Criteria and guidelines for solid waste (including sludge) disposal onto land which are planned to be developed and issued under Pub. L. 94-580 should provide more specific guidance. Detailed reports are being planned to supplement the Bulletin and provide the detailed data base and information on other topics of concern to municipal sludge management.

(f) Clearly conflicting comments were received regarding the general tone of the proposed bulletin towards land application of municipal sewage sludge. Many comments indicated that the intent of the Bulletin was far too restrictive on agricultural use of sludge. Others felt that the coverage of cropland uses was too liberal. Both support of and opposition to the application of municipal

sludge to parklands, disturbed land and forests were indicated by different commenters. The revised document attempts to encourage the beneficial utilization of municipal sludge as a resource, and cites experience as guidance in evaluating construction grant applications on sludge utilization procedures that have experienced no known environmental problems.

(g) Numerous comments were received concerning the intent of this document towards supporting the utilization or disposal of municipal sludges. Since land application of many sludges can be beneficial to the soil and crops, this method would be preferable to sludge disposal practices that preclude these beneficial effects. Of course, these practices should be implemented in a manner that is also environmentally acceptable. The guidance given in the Bulletin concerning the utilization of sludge by land application is intended to provide maximum flexibility to minimize possible environmental problems, since the available information is still limited.

(h) Comments received in regard to the monitoring requirements of the proposed document generally favored the need for some monitoring of sludge disposal and utilization projects, but disagreed on the extent to which monitoring should be required. The revised document recommends the development of an adequate baseline analysis for specific heavy metals and persistent organic compounds in the sludge to provide the basis for additional site-specific monitoring requirements. The monitoring plan developed for a land application project should be designed for the local site conditions, project operation and sludge analysis.

(i) Numerous comments were received regarding the importance of adequate pretreatment requirements to control industrial discharges of contaminants into publicly-owned sewage treatment works that may eventually create sludge management problems. The Bulletin strongly emphasizes the importance of pretreatment as a means of reducing the contaminant levels in sludges, while not specifically addressing possible pretreatment actions. The Agency has embarked on an accelerated program under Pub. L. 92-500 to develop (1) pretreatment standards for the most significant polluting industries, and (2) standards pertaining to the discharge of designated toxic pollutants. Additionally, the Agency has recently issued revised pretreatment guidelines to assist municipalities in developing local pretreatment requirements.

(j) A number of comments were received regarding the determination of appropriate application rates for sludges applied to the land. Most agreed with the approach taken in the proposed document calling for maximum application rates to be based upon crop nitrogen needs and groundwater concerns. Therefore, this approach was maintained in the final document.

(k) Numerous comments were received

indicating a need for defining, or at least clarifying, the meaning of such terms as "stabilization," "food chain and non-food chain crops," "utilization and disposal," "agricultural and non-agricultural uses," "high/average/low sludge quality" and "application rates." Efforts were made in the final bulletin to provide definitions or at least clear indications as to the intended meaning of such terms. In addition, an appendix is included that provides typical values observed for various contaminants in municipal sludge under different circumstances.

(l) Numerous comments were directed at the technologies available to meet the stabilization requirements of various sludge management practices. It was generally agreed that the stabilization discussion in the proposed document was too restrictive. In the revised Bulletin, efforts were taken to establish the need for stabilization, but not to provide a complete list or details of available stabilization technologies. The reader should refer to the "Process Design Manual for Sludge Treatment and Disposal" (EPA 625/1-74-006; October 1974) for more specific information on sludge stabilization techniques.

(m) Several comments were received indicating the need for clearer guidance on when additional pathogen reduction techniques are required and what pathogens need to be controlled. The final Bulletin indicates that under certain site-specific project conditions, pathogen reduction list of methods that have been used to further reduce pathogen levels in sludge. Since the conditions that would require the need for additional pathogen reduction are generally site- or project-specific, no attempt was made to identify when this would be required, except with regard to the production of directly consumed human foods.

(n) Numerous comments were received regarding the restrictions recommended for the protection of food products and agricultural land. Most, but not all, reviewers agreed that this section was too restrictive as presented in the proposed document. Many reviewers strongly opposed the restrictions requiring (1) three years after sludge application before human food crops may be grown to be eaten raw, and (2) the sludge applied to be negative for *Salmonella* and *Ascaris* ova if applied to soils where crops are grown which are normally cooked in the home before consumption, but marketed without being subjected to a process which is lethal to pathogenic microorganisms and pathogens.

The revised document encourages the use of stabilization methods together with additional precautions to minimize pathogen, parasite and viral content of sludge used in agriculture. Application methods that prevent direct contact of the sludge with the portion of the crop to be consumed are encouraged. The Bulletin also recommends that projects conform to any limitations for crop quality (both human and animal feeds)

established by FDA, USDA or State agencies.

The Technical Bulletin exclusive of the cited appendices is printed below. A copy of the complete Bulletin, including appendices, may be obtained by writing to the General Services Administration (8FFS), Centralized Mailing Lists Services, Bldg. 41, Denver Federal Center, Denver, Colo. 80225. Please indicate the title of the publication and the document number: MCD-28 (EPA 430/9-77-004).

Dated: October 26, 1977.

THOMAS C. JORLING,
Assistant Administrator,
Water and Hazardous Materials.

TECHNICAL BULLETIN

MUNICIPAL SLUDGE MANAGEMENT:
ENVIRONMENTAL FACTORS

CONSTRUCTION GRANTS PROGRAM, OFFICE OF
WATER PROGRAM OPERATIONS, U.S. ENVIRONMENTAL
PROTECTION AGENCY, WASHINGTON,
D.C. 20460

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Appendix IV—Standards of performance for new stationary sources; Subpart 0—Standards of Performance for Sewage Treatment Plants, 40 CFR 61.150, and proposed amendment.

Appendix V—"National Emissions Standards for Hazardous Air Pollutants," Subpart E—National Emission Standard for Mercury, 40 CFR 61.50.

Appendix VI—Subchapter H—Ocean Dumping, 40 CFR 220-229 (42 FR 2462-2490) January 11, 1977.

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U.S. ENVIRONMENTAL PROTECTION AGENCY

TECHNICAL BULLETIN

MUNICIPAL SLUDGE MANAGEMENT: ENVIRONMENTAL FACTORS

Foreword

This Technical Bulletin has been prepared to assist Environmental Protection Agency (EPA) Regional Administrators in evaluating grant applications for construction of publicly owned treatment works under section 203(a) of the Federal Water Pollution Control Act as amended. It also provides designers, municipal engineers and others with information on sludge management options.

The Bulletin was developed from the outputs of an Agency workgroup that attempted to prepare an Agency policy statement and guidelines on sludge management. These efforts were undertaken with substantial assistance provided by individuals from the Council on Environmental Quality, the U.S. Department of Agriculture, the Food and Drug Administration, and the Department of the Army.

The relative risks, benefits and costs of various sludge management practices should be thoroughly considered when evaluating potential alternatives for specific projects. While some degree of risk is inherent in any sludge management option, trade-offs among risks, benefits and costs should help direct projects toward the selection of both an environmentally and economically viable utilization or disposal alternative.

The Bulletin addresses only factors important to the environmental acceptability of particular sludge management options and does so in a general manner to allow a maximum flexibility in its interpretation to meet varying Regional needs and site specific factors. It was not written as a regulatory document or design manual. An environmental assessment/environmental impact statement procedure is used to determine the acceptability at a specific site. This procedure is described in EPA's regulations for "Preparation of Environmental Impact Statements" (40 CFR 6, Appendix I).

The cost-effectiveness of a proposed sludge management option is of great importance. Information on the EPA cost-effectiveness program is contained in Appendix I. Detailed

information on pretreatment guidelines and regulations, sample collection/preservation/analysis procedures, as well as in-depth reviews of the somewhat controversial potential environmental impacts of land application are or will be covered in additional supporting documents.

While the main body of the Bulletin includes considerable detailed information on land application alternatives, it is not intended to indicate a preference for this or any other sludge management option. The Bulletin emphasizes land application alternatives since no EPA guidance has been issued on this subject in the past. It incorporates existing Agency guidance (and regulations where applicable) on the other major options—incineration, landfill, and ocean disposal—mainly by means of references and appendices. It is important that all of the available options must be considered, including incineration and landfilling as well as land application, to assure that the best alternative, in terms of environmental acceptability, cost-effectiveness, and benefit, is selected.

The requirements of the Act for higher levels of wastewater treatment will result in a substantial increase in the quantity of sludge produced at publicly owned treatment works. Disposition of these sludges is not simple. Methods used in the past are now restricted by specific laws or regulations, or are subject to other constraints in view of new information of environmental significance.

EPA, continuing the work of its predecessor agencies, has been developing environmentally acceptable methods for the management of municipal sludge since the enactment of the first Federal water pollution control laws. The initial phases of the research program were concerned with the characteristics and dewatering properties of primary and secondary sludge because of the need to dewater sludge before its ultimate disposal. The current program emphasis has shifted toward development of improved technology for returning the sludges to the environment in an acceptable manner. Also, the Agency is requiring new measures, such as source control and pretreatment, which should reduce the heavy metals problem associated with sewage sludges.

The Agency has been aware of the growing sludge disposal problem and the need to verify and expand the technology that is now being utilized. For example, a long-term land application project has been directed at determining the beneficial uses of sludge for strip mine reclamation and for soil enrichment in crop production. These studies have carefully monitored the heavy metals uptake in various forage and grain crops.

A large increase in the amount of sludge generated has occurred with the use of chemical precipitants for nutrient control and the upgrading of secondary treatment facilities. The Agency has been actively developing new technology for solving the problem, including recovery and reuse of the chemical additives.

EPA will continue its broad based research program for municipal wastewater sludge management. Depending on the availability of resources, we will concentrate on demonstration of new technologies which will recycle or reuse resources, reduce energy requirements, or recover residuals contained in sludges.

For example, new technologies are being examined to determine if there are cost-effective methods for producing or recovering marketable products in the processing of sludge. These products may include: metals recovery, simple organic acids, fertilizer bases,

soil conditioners, the recovery of process heat, fuels for energy production, and activated carbon.

Health effects research will include investigation into land application, disinfection, composting, and airborne contaminants from incineration. The improved technology for reducing or eliminating pollutant emissions to the environment will be evaluated from a health and ecological effects standpoint. It is also EPA's intent to continue cooperative agreements with local, State, and other Federal agencies.

The Technical Bulletin is based on current knowledge. It will be modified from time to time as additional information becomes available from current and future research, development, and demonstration projects as outlined above. New research, development, and demonstration projects which offer potential for reducing costs or improving technology are encouraged; this includes projects that do not meet the specific recommendations of the bulletin, if there is reason to believe that they will eventually be acceptable. This Bulletin will also be supplemented by a series of detailed technical reports on topics of major concern. The first: "Application of Sewage Sludge to Cropland: Appraisal of Potential Hazards of the Heavy Metals to Plants and Animals" (EPA 430 9/78-013) is already available. (A copy of this report can be obtained by writing to the General Services Administration (8 FPS), Centralized Mailing Lists Services, Bldg. 41, Denver Federal Center, Denver, Colo. 80225. Please indicate the title of the publication and MCD-33.)

It is believed that the techniques discussed in this bulletin can be environmentally acceptable if properly designed, constructed and managed. It must be well understood that proper operation, maintenance, and monitoring of any sludge management system are essential. The operators of such systems must clearly demonstrate the managerial capability and resources necessary to achieve and maintain the expected performance on a continuing basis.

The guidance and recommendations in this technical bulletin are subject to revision based on future experience in the field. All users are encouraged to submit suggested revisions and information to the Director of the Municipal Construction Division (WH-547), Office of Water Program Operations, U.S. Environmental Protection Agency, Washington, D.C. 20460.

Dated: October 26, 1977.

THOMAS JORLING,
Assistant Administrator,
Water and Hazardous Materials.

U.S. ENVIRONMENTAL PROTECTION AGENCY

TECHNICAL BULLETIN

MUNICIPAL SLUDGE MANAGEMENT: ENVIRONMENTAL FACTORS

Chapter I

Introduction

1-1. The treatment of wastewaters for pollutant removal produces not only relatively clean water for discharge, but also a significant quantity of residue material. For domestic sewage, treated in publicly owned plants, this residue is essentially organic in nature, although measurable quantities of metals, minerals, and other compounds are also invariably present. The residue may also contain pathogenic organisms which survive the wastewater treatment process. Where industrial wastewaters are treated together with domestic sewage, the potential for addi-

tional materials of concern in the resulting sludge is increased.

1-2. Depending upon the composition of the wastewater treatment plant sludge and the quantity involved, disposal of this residue material can have a significant impact on the environment. It is essential for wastewater treatment installations to consider the proper disposal of treated wastewater, as well as all byproducts and residues such as sludge. The requirements of the Federal Water Pollution Control Act, as amended (Pub. L. 92-500), emphasize the need for environmentally sound means for sludge utilization or disposal. The national requirement under Pub. L. 92-500 for secondary treatment, for example, will result in production of greater quantities of sludge.

1-3. The disposition of wastewater treatment plant sludges is a complex problem. It can affect the quality of air, land, and water, and requires considerations of human health, animal health, plant growth, and protection of ground and surface water from pollution. EPA Regional Administrators must consider all these matters as they evaluate sludge management systems included in the design of publicly owned treatment works for which construction grant applications are made. Despite the still limited information available on the complex issue of sludge utilization and disposal, the need for definition of a baseline of acceptable sludge utilization or disposal practice remains. Such a baseline is planned for development under the authorities of the Resource Conservation and Recovery Act (Pub. L. 94-580).

1-4. For the reasons cited above, a description of items to consider when selecting a specific sludge utilization or disposal alternative are presented in this document. This technical bulletin provides general guidance on the factors to be considered in the environmental assessment and to be used in reviewing the facts of a particular situation. For the utilization and disposal methods discussed no attempt is made to limit the implementation of innovative technologies or to imply that any particular method is optimum for sludge utilization or disposal. The final determination of acceptability should be based on the environmental assessment and, if necessary, the environmental impact statement for a specific project.

1-5. The bulletin is divided into two distinct parts. The first part includes methods in which the sludge is utilized as a resource by land application. The second part describes those methods where a beneficial use is not emphasized. System involving the recovery and utilization of energy or residuals contained in sludges are not specifically covered in this document. Examples of such systems are the production and utilization of digester gas, incinerator gas or steam; recovery and reuse of chemical conditioners; recovery and sale of metals. However, the environmental impacts associated with energy recovery systems would be similar to those identified for the sludge incineration practices covered in this bulletin.

1-6. Methods which may have future promise, but which have not been used in existing facilities, are not included. As these developing technologies are demonstrated in practical use, and as supporting information is obtained, they will be added in updates of this bulletin. Because it is the policy of EPA to encourage and, where possible, assist in the development of new or advanced wastewater treatment procedures, Federal grant funds may be awarded for the construction of sludge utilization or disposal facilities not addressed in the bulletin, provided sufficient information is presented by the grant appli-

cation. Smaller plants usually use sludge to determine that these facilities would meet applicable statutory and regulatory requirements and would be environmentally acceptable.

1-7. Proper operation, maintenance, and monitoring of sludge utilization or disposal practices are essential to ensure that adverse environmental effects do not result. Grant applicants must demonstrate that they will have managers, operators, and resources necessary to achieve and maintain the required performance on a continuing basis.

1-8. Efficient energy utilization, conservation and recovery are increasingly critical topics. Full consideration of these factors is necessary in the comparison of alternatives in the selection of a sludge management method.

Chapter II

LAND APPLICATION OF SLUDGE

2-1. *General.* In order to contribute to energy and resource conservation in wastewater treatment facilities, sludge management technologies which will beneficially recycle or reuse sludges are actively encouraged. Because land application of sludge provides an excellent soil conditioner while conserving and recycling organic matter, nitrogen, phosphorus, and certain essential trace elements, such utilization is encouraged when it is supported by an environmental assessment.

Specifically, the use of stabilized sludge by land application for enhancement of parks and forests and reclamation of poor or damaged terrain should be considered for the utilization of sludge. Application of stabilized sludge to agricultural lands may also be regarded as an environmentally acceptable method of sludge utilization/disposal, but must be examined closely in terms of protection of human health and future land productivity. This is due to the present limited knowledge and uncertainties as to the extent to which this practice could result in the entry of toxic substances into the human food chain and pose a health risk.

Regulations, criteria, and guidelines being developed under the authorities of Pub. L. 92-500, TSCA, RCRA and other recent environmental legislation may impact the future acceptance of various land application practices in various ways. The development of criteria and guidelines under RCRA will define acceptable levels of pollutants for land application of solid wastes. The implementation of the anticipated Agency pretreatment strategy now under development will substantially reduce contaminant concentrations of many municipal wastewater treatment plant sludges (especially cadmium and persistent organics). These efforts should further enhance the acceptability of sludges for agricultural uses. By this emphasis on prevention of future problems, we hope to move toward a goal of waste recovery and recycling.

The environmental concerns associated with the beneficial utilization of sludge by land application practices are discussed at length in the following paragraphs.

2-2. Information for Project Evaluation.

2-2.1 *Sludge characteristics.* Sludge from existing plants should be tested to determine nutrient values, heavy metals, and other constituents which may be economically recycled or cause environmental damage (Appendix VII). The type of tests and their scheduling is site specific and dependent on regulatory requirements, the intended use of the sludge, the contaminants likely to be present, and the intended use of the crop if one is grown. For new projects, it will be necessary to estimate the sludge characteristics; the application rates actually used on

a project should, however, be based upon actual sludge analyses. Some indication may be available from pilot plant studies, but such studies are rarely conducted at smaller plants.

When sludges are to be applied to land, for beneficial purposes, appropriate non-domestic users of municipal wastewater treatment works should be required to pretreat their wastewaters to minimize the presence of potentially harmful heavy metals and other sludge contaminants from industrial sources. Pretreatment requirements should meet Federal pretreatment standards. (Current pretreatment regulations are covered in 40 CFR Parts 128 and 403. Also, see "Federal Guidelines: State and Local Pretreatment Programs," EPA 430/9-76-017 a, b, c.) However, quantities of these materials also may be present in wastewaters usually considered of non-industrial origin.

2-2.2 *Site soils.* Soils receiving sludge for agricultural purposes, should be tested for phosphorus, potassium, pH, and heavy metals. There should also be knowledge of the approximate soil cation exchange capacity. Soils data and surveys are available through the Soil Conservation Service. Soil testing also can be arranged through local county agricultural extension agents, State Agricultural Experiment Stations and private laboratories. The number and extent of these tests may be minimal for largely domestic sludges where the application rates are low (paragraphs 2-3.10 and 2-4), or where certain soil survey information already exists.

2-2.3 *Groundwater.* A review of existing information and/or an investigation of groundwater conditions should be made for sites where sludge is to be applied to the land at greater than crop fertilizer rates (paragraph 2-3.8). Attention should be paid to the sites' geology and soil physical properties to avoid areas underlain by highly porous, fractured or stratified formations. The extent of the evaluation should be based on the size of the project and the potential impact on groundwater. Maintaining the pH of the combined soil and sludge above 9.5 will help prevent subsolubilization and migration of most metal ions into the groundwater.

2-3. General Requirements for Land Application of Sludges.

2-3.1 *Stabilization.* Under most circumstances sludge should be stabilized (by means of chemical, physical, thermal, or biological treatment processes that result in the significant reduction of odors, volatile organics and pathogenic organics) before land application to reduce public health and to prevent nuisance odor conditions. The stabilization method most frequently used has been anaerobic digestion, but there are numerous other methods producing comparable results. Discussions involving stabilized sludge in this document are based on a product equivalent to, or better than anaerobically digested sludge.

Experience shows that consistent and effective control of odors is a major factor in the public attitudes toward sludge transport, sludge storage and land application techniques. The order conditions are closely related to anaerobic bacterial action on volatile organic matter in both the liquid and solid portions of the sludge. The degree of volatile matter reduction achieved by anaerobic digestion may vary greatly, depending on the basic digester design and the percentage of volatile solids in the raw sludge. Well designed and carefully operated high rate anaerobic digesters can digest sludge to control odors and reduce pathogen concentrations when the sludge is digested for a least 10 days at 95° F. Such high rate digestion requires close operational control for successful per-

and rate digestion. [Although digestion can reduce the number of influent fecal coliforms by 97 percent or more, the remaining levels of microorganisms may still have public health significance.]

Other methods to prepare sludge for land application may be used. Some examples are: composting of raw as well as digested sludge, aerobic digestion, chemical treatment (lime treatment, etc.), heat stabilization, or heat drying. In cases where stabilization is determined to be necessary, the grant applicant should show that the performance of the alternative used for preparing the sludge is equivalent to anaerobic digestion in reducing odor potential and volatile organics.

Chemical treatment of sludges may only provide temporary inhibition of odors. Incorporation of the sludge into the soil is recommended for those sludges which have odor potential (paragraph 2-3.7).

At some plants, stabilized sludge is spread on drying beds or temporarily stored in properly designed sludge lagoons. These methods decrease subsequent odor problems from sludge applied to land since additional stabilization occurs with time. Caution must be exercised, however, to ensure that there are no objectionable odors from the storage site.

2-3.2 Additional pathogen reduction. Under certain conditions (e.g., due to State regulatory requirements controlling public access or for projects involving hospital wastes), it may be necessary to achieve additional bacteria, parasite, and/or virus reduction or deactivation beyond that attained by stabilization. The following methods have been used:

- a. Pasteurization for 30 minutes at 70° C.
- b. High pH treatment, typically with lime, at a pH greater than 12 for 3 hours.
- c. Long-term storage of liquid-digested sludge for at least 60 days at 20° C or 120 days at 4° C.

d. Complete composting at temperatures above 55° C as a result of oxidative bacterial action and curing in a stockpile for at least 30 days.

e. Both gamma and high energy electron ionizing radiation under various application procedures including combination treatment with thermal conditioning and oxygenation.

2-3.3 Crops suitable for sludge application. Crops vary in their reaction to sludge-enriched soils. Most crops benefit from the nutrients, such as nitrogen and phosphorus, and organic matter present in the sludge. However, some crop species may be adversely affected by excess heavy metals or other contaminants. Additionally, the crop may take up and accumulate certain of these trace elements, and possibly inhibit future use of the harvested materials, particularly those in the human food chain.

The degree of contaminant uptake by different crops and specific plant tissues is highly variable. For example, vegetative portions of grasses generally contain higher levels of heavy metals than the grain. Factors such as soil type, pH, moisture, and organic matter content, crop species and variety (and for cadmium, the annual and accumulative application rates) are all important and affect plant uptake rates of specific contaminants. Vegetables such as lettuce, spinach, and chard, as well as tobacco are among the highest accumulators of heavy metals such as cadmium. USDA extension and research offices and State Agricultural Experiment Stations are available for additional guidance on the selection of crops which can be satisfactorily grown on sludge enriched soils in specific geographic areas.

Forest sites and reclamation projects offer special opportunities for beneficial use of sludge to improve soil fertility and increase plant growth without significant risk to pub-

lic health. In these cases it will still be necessary to comply with regulatory requirements pertaining to impacts on air, surface waters, and groundwaters, in a manner similar to that described for agricultural uses (paragraph 2-3.5).

2-3.4 Public access should be controlled in a positive manner where applications are above rates for agricultural use. In such instances, posted notices, and/or simple barriers, fences, remoteness of the site should be adequate.

2-3.5 Groundwater protection. Projects for land application of sludges will be designed so that the permanent groundwaters (groundwater which is not removed from the ground by an underdrain system or other mechanical means) in the zone of saturation (where the water is not held in the ground by capillary tension) will be protected from pollution. Consideration should be given to the extent of the project, the quality of the groundwaters, and the fact that groundwater is typically used for drinking water supply with little or no additional treatment. Also, in some areas, groundwater recharge of surface streams may be significant. Specific groundwater criteria will be developed under Pub. L. 94-580. Until such criteria are developed under Pub. L. 94-580, criteria contained in the EPA publication, "Alternative Waste Management Techniques for Best Practicable Waste Treatment," EPA 430/9-75-013 should be followed. An extract on groundwater is reproduced as Appendix II to this Bulletin.)

2-3.6 Controlling surface water runoff. Sound engineering practice requires the control of surface runoff that may leave the site as well as that which will enter the site from contiguous properties. Controlled release of runoff from sludge application areas and effective erosion control methods must be practiced as necessary. Consideration should also be given to materials which may leach out of the sludge. Surface water criteria are to be developed under Pub. L. 94-580.

2-3.7 Sludge application methods. Techniques for applying liquid sludge to the land include: tank truck, plowing, injection, or ridge and furrow spreading. Dewatered sludge, or composted sludge, may also be spread upon the land. If desired, the sludge can be incorporated into the soil by plowing, disking, or other similar methods. The use of incorporation and injection methods is encouraged as a means of improving public acceptance of sludge application by decreasing possible odor generation and unsightly deposits on crops.

Sprinkler application of digested sludge to the land is acceptable when the transport of aerosols beyond the boundaries of the application area is minimized. The use of low pressure sprinklers, short risers, or remoteness of application sites is suggested. When sprinkling at low pressures, it is good engineering practice to screen the sludge or otherwise prevent nozzle plugging.

2-3.8 Application rates. The sludge application rate per acre should be determined in a manner to ensure that environmental requirements are met. Nitrogenous substances usually limit annual application rates. The rate of sludge application to land should be consistent with the requirement to prevent nitrate pollution of groundwater as previously defined (paragraph 2-3.5). The information required to establish the maximum sludge application rate based on plant available nitrogen includes: (1) total and inorganic nitrogen content of sludge; (2) nitrogen, phosphorus, and potassium requirements of crop proposed; and (3) soil test for available nitrogen, phosphorus and potassium. Supplemental fertilizer, especially potassium, may be needed if optimization of crop production is desired.

As a guide, sludge application rates should provide total plant available nitrogen equivalent to the nitrogen fertilizer requirement of the crop grown, although some experience in applying 1½ to 2 times the crop's nitrogen fertilizer requirement has not led to the development of groundwater problems. Plant available nitrogen includes that mineralized from the soil, the inorganic sludge nitrogen (ammonium and nitrate), plus a mineralization rate of 15 to 20 percent of sludge organic nitrogen (mineralizable organic nitrogen) for the first growing season following application, and three percent of the residual sludge organic nitrogen for three subsequent growing seasons. Volatilization of ammonia from surface applied sludge should be taken into account; experience has shown that about 50 percent of this nitrogen may be lost if the material is not immediately incorporated. Denitrification may also be a factor accounting for significant nitrogen losses under certain conditions.

Sludge nitrogen mineralization, volatilization, and denitrification rates may vary considerably for different climatic areas of the Nation. USDA extension and research offices, and State Agricultural Experiment Stations should be contacted to obtain specific regional information on nitrogen transformation rates, plant nitrogen, phosphorus and potassium requirements and soil test information for the local area.

An excess of certain salts, phosphorus compounds, heavy metals, persistent organic compounds, radionuclides and other materials in sludges may also limit application rates. Each prospective land application site should be assessed on an individual basis, with adequate consideration given to sludge characteristics, soil characteristics, crops to be grown, and other factors such as surface water and groundwater protection. Control of the total and annual application rates along with soil pH control and intensive monitoring programs are possible approaches which can be used to avoid problems with major contaminants of concern such as cadmium (section 2-4.2). A useful procedure for calculating the rate of sludge application to the land based on the nitrogen requirement of the crop grown and the nitrogen and metal content of the sludge is given in Appendix VIII.

Sludge is generated continuously throughout the year, but continuous field application may not be possible. A mass balance is necessary to determine the amount of sludge storage required during intervals when the sludge is not applied to the land.

2-3.9 System operation. The grant applicant should show the capability to manage and operate the system. Operational aspects to be described in the operation and maintenance manual include the monitoring plan, review of monitoring data, action to be taken when monitoring indicates a problem, and a commitment to use expert guidance when required. The operation and maintenance manual should specifically indicate what actions can be taken to either upgrade the site to acceptable levels or discontinue its use if it is shown to be in violation of future requirements developed by Federal or State regulatory agencies.

USDA extension and research programs are also available to help develop and provide site specific recommendations for the best agricultural practices for use of municipal sewage sludge by farmers on privately owned lands. Extracts from such guidance that has been developed for the North Central and Western states is provided in Appendix VIII. These recommendations may include suggestions to help minimize or eliminate some monitoring requirements on the farm while protecting farmland for future agricultural use, maintaining normal productivity, and assuring continued farm income.

2-3.10 Monitoring. The grant applicant should develop and implement a plan for adequate monitoring of each land application site where the application rate may impose a significant nitrogen loading on receiving ground or surface waters (paragraph 2-3.8), where greater rates of metals are applied than indicated in section 2-4.2 or where hazards are expected from other sludge constituents such as pathogens are persistent organics. Groundwater monitoring generally should not be required where the application rate is based upon the nitrogen fertilizer needs of the crop (paragraph 2-3.8).

It will always be necessary to know the characteristics of sludge (paragraph 2-2.1) to be applied. For new projects, it may be necessary to monitor more frequently until successful performance is assured.

The monitoring plan should be specifically designed for local conditions including site and sludge characteristics, proposed rate of application, crops to be grown, size of the project, etc. Where necessary, the plan should consider monitoring heavy metals, persistent organics, and pathogens, as well as nitrates in groundwater, surface water, sludge and soils. In addition to these recommendations and local or State requirements, additional monitoring requirements may be developed under Pub. L. 94-580.

2-3.11 Surveillance of operation and monitoring. The operation and monitoring data of the system must be periodically reviewed by the responsible regulatory Agency or agencies to ensure satisfactory performance. Where there is no local or State program for this purpose, an alternative independent review should be established. The grant application should show the arrangements made for surveillance.

Operational and monitoring data must be available to authorized local, State, EPA and other Federal agency representatives on request.

2-4. Additional requirements for sludge application to agricultural lands. In addition to the foregoing general requirements, the application of sludge to agricultural lands should be accomplished so as to ensure cropland resources are protected and harmful contaminants are not accumulated in the human food chain to create a risk to public health. Review of projects which include application of sludge to agricultural lands must be based on informed judgment and fully consider the conditions specific to a given site.

2-4.1 Research, development and demonstration projects. As indicated earlier (paragraph 1-6), it is the policy of EPA to encourage and, where possible, assist in the development of new or advanced wastewater treatment procedures, including sludge processing, utilization and disposal practices. Therefore, proposals involving the demonstration of new and innovative technologies for sludge management should be encouraged and expedited.

For such demonstration projects (e.g., reclamation of disturbed land with sludge), where significant resources and manpower are available for control and monitoring, the recommendations within this Bulletin may be exceeded in an effort to investigate new approaches for sludge management. An environmental assessment should verify that this is the case for particular projects. Some demonstration projects have the capability (including in-house effort and consultant assistance) to intensively monitor and evaluate the project as it develops. Work on these projects should be closely coordinated with EPA, USDA and FDA, as well as State and local authorities, to ensure satisfactory results including acceptable crop quality if crops grown are to be marketed (as described

under section 2-4.2 B). Control criteria for these projects should be subject to continuing modification as information is developed. For these research, development and demonstration projects, the Agency review should assure that adequate resources are made available for the evaluation of project performance, arrangements are established for surveillance of the project, and review of project data is arranged for EPA and other interested agencies such as FDA, USDA, State Agriculture and Health Departments.

2-4.2 Protection of food products and agricultural lands. Regulations exist to control the level of mercury and persistent organic chemicals, such as pesticides and polychlorinated biphenyls (PCBs), in certain components of the human food chain. However, similar regulations have not been established for all contaminants in foods. When other regulations are implemented, those sludge land application projects involving the production of crops in the human food chain will have to produce crops that conform to these regulations. Contaminants of particular concern in municipal sludge as related to the production of human food and animal feed crops are cadmium and lead, as well as mercury, arsenic, selenium, and persistent organics such as pesticides and PCB's.

A wide variety of site specific conditions and management variables can affect the level of heavy metals entering crops. These variables have been and continue to be examined by many groups within FDA, USDA and State agencies. It is therefore recommended that projects conform to limitations for crop quality (human food or animal feed) established by these agencies.

The available information concerning the benefits and potential impacts of applying municipal sludge to agricultural land has been reviewed and summarized elsewhere. This available information indicates that many municipal sewage sludges can be applied to agricultural land when good agricultural management practices are employed. Upper limits on annual heavy metals loadings were suggested by various sources, based upon the currently available data base, with the anticipation that modifications will be made in time based upon additional research.

As discussed in section 2-1 elsewhere, regulations, criteria and guidelines being developed under authorities of Pub. L. 92-500, TSCA, RCRA and other recent environmental legislation may impact the future acceptance of various land application practices in various ways. Pretreatment requirements and solid waste disposal and utilization criteria and guidelines currently under development will provide numerical limitations aimed at reducing the levels of pollutants discharged into the environment, including allowable cadmium additions to agricultural soils through solid waste (including municipal sludge) application. As a result of progressively imposing more stringent pretreatment regulations on industrial wastes discharged into municipal systems, there should be a corresponding reduction of sludge borne contaminants.

Until regulatory requirements are established, the following guidance will allow for the application of most sludges to agricultural land at crop nitrogen fertilizer rates (paragraph 2-3.8).

A. Privately owned agricultural lands. The following guidance is suggested for application of municipal sludge to privately owned and managed cropland. These recommendations should protect private farmlands for future agricultural use, maintain their normal productivity, and assure continued farm income while minimizing monitoring requirements to those normally used for assuring good soil management:

(i) **Annual cadmium loadings.** The maximum annual loading of cadmium that should not be exceeded when applying sludge to agricultural land depends upon site conditions and management practices employed. The annual cadmium loadings that have been used successfully range from less than 1 kg/ha up to 2 kg/ha. While lower cadmium application rates are preferable, in those cases where good site conditions (i.e., high pH soils) and good management practices (i.e., soil pH control, monitoring, selecting crop species and varieties that do not readily take up heavy metals, etc.) prevail, annual loadings of 2 kg/ha have been employed. Because of the concern over potential health effects from increased ingestion of cadmium in foods, it is the intent of EPA to move toward minimizing cadmium additions to cropland. Movement toward lower cadmium additions will be reflected in the criteria for land application of solid wastes to be developed and issued under the Resource Conservation and Recovery Act of 1976 (Pub. L. 94-580).

(ii) **Soil/sludge pH control.** The pH of the soil/sludge mixture should be controlled to limit heavy metal uptake by plants. A pH of 6.5 or greater will minimize uptake of most heavy metals by most crops. As soil pH drops, heavy metal solubility in soil and availability to crops is increased. Under some site specific conditions (as in many strip-mined areas), availability of metals present in the soil before sludge application can actually be reduced by the application of sludge, because sludge addition in itself may tend to raise soil pH of a highly acid soil and because binding of the heavy metals into organic complexes may occur. But it is rare that the final pH will be 6.5 or greater. Therefore, consideration should be given to including supplemental liming. Additional guidance on tailoring soil/sludge pH to specific cropping systems may be gained from local agricultural extension agents, State Agricultural Experiment Stations, USDA, etc. The pH level maintained should be designed to meet the intent of limiting heavy metal solubility in soil and possible movement of heavy metals into groundwater or into crops by uptake.

(iii) **Total cumulative metal loadings.** It has been demonstrated that the following total cumulative metal loadings from applying municipal sludge to agricultural land have not led to observed problems (when soil pH is controlled):

Metal	Soil cation exchange capacity (milliequivalent per 100 g)*		
	0-5	5-15	>15
Amount of metal (kilogram per hectare)			
Pb.....	500	1,000	2,000
Zn.....	250	500	1,000
Cu.....	125	250	500
Ni.....	50	100	200
Cd.....	5	10	20

* Cation exchange capacity (CEC) determined on soil prior to sludge application by pH 7 ammonium acetate procedure.

NOTE.—It is recognized that soil CEC is not the only factor important in setting levels of metal additions to soil. While its use as an index is recommended (providing that soil pH is also controlled) other factors such as soil colloidal, organic and sesquioxide contents may be equally or more important in limiting metal availability.

(iv) **Calculating sludge application rates.** A useful procedure for calculating the rate of sludge applications to the land (paragraph 2-3.8) based on the nitrogen and metal content of the sludge is given in Appendix VIII.

In addition to the above, the following measures are also suggested as possible means

to overcome problems of dealing with highly contaminated sludges:

(v) *Ratio of cadmium to zinc in sludges.* It is suggested that in naturally acid soils the ratio of cadmium to zinc in sludge should be considered in addition to total annual rates of application. An important premise of this concept is that with poor management (e.g., improper crop selection and low soil pH), high enough zinc concentrations in soil to kill plants would result before cadmium could accumulate to levels in foods considered hazardous to animals and humans. The preferred practice suggested by USDA and some researchers is to apply sludges (to naturally acid soils) with a Cd/Zn ≤ 0.015 to these privately owned croplands.

(vi) *Pretreatment programs.* Implementation of a local pretreatment program aimed at reducing metals discharged into the municipal system may help overcome the problems that must be faced when considering the application of highly contaminated sludges to cropland.

(vii) *Other technology.* Use of other technology or management aimed at minimizing impact upon soil, groundwater and surface water, crops and/or the human food chain such as the use of selective crop species and varieties that minimize contaminant uptake or application of sludge at less than crop nitrogen needs. In any case, an expanded monitoring program should be implemented to assure control of pollutant migration and quality assurance of the project. The monitoring plan should be capable of noting trends in crop productivity decline, contaminant uptake in final marketed products, groundwater and surface water quality.

B. *Publicly controlled agricultural lands.* When municipal sludge is applied to publicly controlled (owned or leased) land and crops are grown and harvested, higher rates of application may be used if: (1) the use of these rates is acceptable to the responsible regulatory agency(s), and (2) a detailed monitoring program is established to assure acceptable crop quality and to provide close surveillance of groundwater, surface water and soils. If metal additions exceed those recommended in (A) above, priority consideration should be given to growing crops that are not directly consumed by humans.

If human foods or animal feeds are grown and harvested, higher rates of sludge application may be acceptable if resulting levels of cadmium in the crops or meats marketed are comparable to those levels present in similar crops or meats produced locally or as established by FDA or other responsible regulatory agencies. For example, strip mined land which has been reclaimed through high rate sludge application may be used for producing animal feeds; however, organs (e.g., kidneys and livers) which may accumulate cadmium in animals fed such feeds should not be sold for human consumption unless their cadmium levels are comparable to those found in animals produced locally.

C. *Sites previously dedicated for disposal.* The dedication of publicly controlled or owned land for high rate application (including trenching) to allow maximum utilization of the "dedicated site" for the disposal of municipal sludge has been practiced. This is a particularly useful practice for sludges with high contamination levels or where very high loadings of sludge are desired. Project monitoring is generally established to assure close surveillance of groundwater and surface water as discussed under monitoring of landfills (paragraph 3-1.7).

In cases where crops are grown following the disposal of municipal sludge to such "dedicated sites," the crops are generally not harvested for use as human foods or animal

feeds. However, if human foods or animal feed crops are grown and harvested for further use, the marketing of crops and meats produced should be handled as in (B) above.

In all cases where the application of municipal sludge to agricultural lands and production of human foods or animal feeds is proposed (whether on private land, publicly controlled land, or "dedicated sites"), the project should be coordinated at the State and local levels to include the approval of appropriate regulatory agencies.

Experience has shown that under special conditions specific organisms may survive in the soil for extended periods of time. Therefore, unless pathogen reduction by methods such as those listed in 2-3.3, or other suitable measures have been employed to minimize human exposure to such organisms in sludge, additional precautions should be taken to assure that the impact of pathogenic bacteria, parasites and viruses in sludge used for certain agricultural purposes, will be minimal. Measures that have been used include the following:

(a) Sludge-treated land should not be used for growing human food crops to be eaten raw if the edible portion of the plant is in direct contact with the sludge or soils receiving sludges until one year after final sludge application or longer if there are positive indications of viable *Ascaris* ova. The available data base indicates that *Ascaris* ova may remain viable in soil for three years or longer.

(b) Use of application methods to prevent direct contact of the sludge with the portion of the crop to be consumed.

(c) Application to pasture land should be done in a manner that avoids contact between the freshly applied sludge and grazing animals raised mainly for milk. Forage and pasture crops should not be consumed by these animals when physically contaminated by freshly applied sludge. Particular attention should be given to avoiding problems with lead, cadmium, and PCB's contaminating the milk through direct ingestion of contaminated sludge.

Although crop quality standards have not been established to date for many contaminants, efforts are underway by FDA to develop such limitations. FDA has, however, provided their recommendations to limit the applications of sludge to land used to grow human or animal foods (Appendix IX).

2-4.3 *Project review.* When the project includes application to agricultural land, especially if it involves high application rates (paragraph 2-3.8), or sludges with a high concentration of contaminants (paragraphs 2-2.1 and 2-4.2 and Appendix VII), it may be necessary for the Regional Administrator to consult with USDA and FDA as part of the review process. This is especially true for large agricultural projects. The review must ensure that all applicable State and Federal regulatory requirements are met. Technical assistance during preparation of the grant application and facility plan development is available from these same agencies as well as the appropriate State offices.

2-4.4 *Additional monitoring requirements.* In addition to the monitoring requirements presented in 2-3.10, baseline sludge analysis should be conducted to serve as a sound basis for setting of application rates, selection of crops and determining other monitoring requirements. Sludges should be characterized in terms of the range of their contaminant concentration including heavy metals (such as cadmium, zinc, molybdenum, copper, nickel, lead, mercury, arsenic and selenium) and persistent organic compounds (such as chlorinated pesticides and PCB's). The sludges should also be analyzed for parameters (such as pH, ni-

trogen, phosphorus, potassium, and organic content, and possibly calcium and magnesium).

Where products are grown for human consumption on soils, especially to which greater levels of metals or organics have been applied than in this suggested guidance, crop monitoring may be necessary for suspected problem metals, organics, as well as pathogens and parasites.

Records including analyses should be kept by the sludge generating municipality that include sludge quality, locations receiving sludge, annual and total sludge application rates, crops grown and soil pH.

The monitoring plan should be specifically designed for local site conditions and take into account applicable local, State and Federal regulatory requirements by including consideration of sludges, soils, crops, surface water and groundwater quality.

2-4.5 *Technical assistance and use of other sludges.* In recognition of the fact that the guidance in the preceding paragraphs is based on limited information, technical assistance for planning and designing land application projects is available from several sources. These include EPA Headquarters and National Environmental Research Centers (especially the Municipal Environmental Research Laboratory in Cincinnati, Ohio), FDA, USDA extension and research elements, State Agricultural Experiment Stations, and other sources (Appendix X).

In addition to municipal sludge, other sludges (e.g., sludges produced by treatment of food processing and brewery wastes) may also be acceptable for land application under carefully defined and controlled practices. Because of the potential benefits to agriculture from sludge application carried out under sound agricultural management conditions, full exploration of this and other beneficial use options is encouraged.

Chapter III

Sludge Disposal Methods

3-1. Sanitary Landfill.

3-1.1 *General.* Sanitary landfill of sludge, either separately or along with municipal solid waste, is acceptable when supported by an environmental assessment.

3-1.2 *Landfill procedures.* A sanitary landfill accepting sludge should be designed and operated in accordance with EPA Guidelines for Land Disposal of Solid Wastes (40 CFR 241 Appendix III). Although it does not directly address landfilling of sewage sludge, specific guidance for the proper design and operation of a sanitary landfill are included in EPA's publication, "Sanitary Landfill Design and Operation" (SW-65ts). Each site should also comply with appropriate criteria and guidelines being developed under Pub. L. 94-580 for landfilling of sewage sludge. Proposals involving research, development and demonstration of new and innovative landfill technologies should be encouraged and expedited (as discussed for land application technologies in paragraph 2-4.1).

3-1.3 *Odor Control.* The sanitary landfill must be operated so as to prevent nuisance odors. Normally, the sludge must be stabilized as described for land application (paragraph 2-3.1).

3-1.4 *Precautions for protection of public health.* Sludge stabilization and the daily soil cover are generally adequate protection from direct health hazards. Additional precautions may be necessary if the public has unrestricted access to the landfill site.

3-1.5 *Groundwater protection.* The groundwater underlying the sanitary landfill accepting sludge must be protected and the sanitary landfill must meet applicable State

groundwater protection requirements. A geohydrologic assessment should be undertaken to determine the adequacy of the site prior to use as a sludge landfill.

3-1.6 Operation. If a sanitary landfill accepting sludge is not operated by the wastewater treatment authority, a binding agreement should be required between the wastewater treatment authority and the operator of the sanitary landfill. Such a binding agreement should include necessary assurances of compliance with the requirements and recommendations of the EPA guidelines (40 CFR 241 Appendix III) and criteria being developed under Pub. L. 94-580.

3-1.7 Monitoring. A plan should be developed and implemented to provide for adequate monitoring for each sanitary landfill accepting sludge. This plan should be specifically designed to protect groundwater and to ensure protection of surface waters, in the following manner:

a. Groundwater observation wells tested for heavy metals, persistent organics, pathogens, and nitrates;

b. Where the surface water could be affected by direct runoff or leachate from the landfill receiving sludge, surface water monitoring tested for indicators (such as chemical oxygen demands and total dissolved solids). Additional testing may be necessary if it is determined that a poor quality leachate is entering surface waters.

3-2. Incineration.

3-2.1 General. Sludge incineration and disposal of the resulting ash is an environmentally acceptable method for the disposal of sludge when the environmental assessment shows it to be appropriate. Incineration alone is a volume reduction method rather than ultimate disposal. Volume reduction, however, can be an important consideration where land availability is a problem. After incineration, ash, either dry or in scrubber water, remains to be disposed of to the land. Ash disposal must be designed to protect groundwater, to minimize dust production, and to ensure protection of surface waters. Each site should comply with the criteria being developed under Pub. L. 94-580. Proposals involving research, development and demonstration of new and innovative incineration technologies should be encouraged and expedited (as discussed for land application technologies in paragraph 2-4.1).

Due to the increasing costs and limited availability of energy resources, acceptability and viability of incineration processes is dependent on the ability to recover or reclaim energy from the process. Data available to date indicate that fuel requirements of incineration processes can be reduced by available energy recovery technologies. In some cases, energy recovery can possibly even offset a substantial portion of the energy requirements for the entire wastewater treatment plant. While the basic concepts of energy recovery from incineration of wastes are not new, the application of these concepts to wastewater treatment and sludge management facilities generally require special design considerations. New facilities can be designed from the outset to incorporate the necessary equipment to utilize energy recovered from incineration processes. In existing plants, retrofitting of equipment capable of using recovered energy will be

necessary and could be considered to facilitate incineration where cost-effective. When energy aspects are addressed in incineration system designs, they should evaluate future as well as current energy conservation and recovery considerations.

3-2.2 Industrial wastewaters. When introduced into a municipal wastewater treatment works that practices sludge incineration, industrial wastewaters should be pretreated to reduce to a minimum the amounts of mercury, persistent organics, and radioactive materials. In developing pretreatment programs, special attention must be given to the disposal of sludge created or materials removed during the pretreatment process. Disposal of these materials must be in an environmentally sound manner.

3-2.3 Air Quality. The emissions from the sludge incinerator must not result in violation of ambient air quality standards and must meet the EPA air pollution emission standards of performance contained in the New Source Performance Standards for Sludge Incinerators (40 CFR 60.15, Appendix IV). Sewage sludge incinerator discharges into the atmosphere are not to exceed particulate matter at a rate in excess of 0.65 g/kg dry sludge input (1.30 lb/ton dry sludge input) and gases are not to exhibit 20 percent opacity or greater (except where the presence of uncombined water is the only reason for failure to meet the opacity requirement). These emission limits are based on a venturi scrubber, but any similar equipment which meets the standard is acceptable. Sludge incineration is known to vaporize any mercury present in the incoming sludge. EPA has published Amendments to National Emission Standards which do limit mercury emissions from the incineration and drying of wastewater treatment plant sludges to a maximum of 3300 grams per 24 hour period (40 CFR 61.52, included as Appendix V of this document).

3-2.4 Specific emissions. Tests have shown that sludge incinerator emissions can contain volatilized mercury as well as persistent organic compounds, such as polychlorinated biphenyls, and particulates containing trace amounts of metals such as lead and cadmium. The effect of these compounds which are emitted from the incinerator must be assessed and the sludge should be tested to determine the quantities of compounds present. If the PCB's exceed 25 mg/kg dry sludge, then special measures should be taken to ensure at least 95 percent destruction of persistent organic compounds in incineration. This could consist of testing the performance of an incinerator design to verify satisfactory performance or making allowances in the design. Increased temperature and residence time increase the assurance of destruction.

Regulations being developed under the Toxic Substances Control Act (Pub. L. 94-469) and the Resource Conservation and Recovery Act (Pub. L. 94-580) should be consulted regarding current standards for disposal of PCB containing substances. Proposed rules on PCB's disposal under TSCA (Pub. L. 94-469) were published in the Federal Register on May 24, 1977. Incineration conditions specified therein for materials (PCB mixtures, waste materials, and sludges) that contain 500 ppm or greater of PCB chemical substances (on a dry weight

basis) are 1200° C (100° C) for a two second dwell time. While municipal sewage sludges seldom have contamination levels over 500 ppm, final rules promulgated under Pub. L. 94-469 and those being developed under Pub. L. 94-580 should be consulted regarding the disposal of PCB containing municipal sewage sludge.

3-2.5 Monitoring. A plan must be developed and implemented to provide for adequate monitoring of each sludge incinerator. The stack gas emissions from sludge incinerators must be monitored to ensure compliance with 40 CFR 60.15 (Appendix IV). In addition, mercury, either in the sludge or in stack gas emissions, must be periodically tested to demonstrate compliance with 40 CFR 61.5 (Appendix V). Wastewater from industrial users must be monitored if it is determined that such users will be a significant source of mercury in the municipal sludge. Additional monitoring for organic pesticides, PCB's or heavy metals other than mercury, may be necessary for specific projects.

3-3. Ocean Disposal.

3-3.1 General. Although approximately 15 percent of the current sludge volume produced in municipal treatment plants is now disposed of into the oceans; the practice of ocean dumping is now being done only under interim ocean dumping permits, because the sludges do not meet existing ocean dumping criteria. Sludge dumping is scheduled to be phased out by the end of 1981.

The Federal Water Pollution Control Act as amended (Pub. L. 92-500), and the Marine Protection, Research and Sanctuaries Act of 1972 (Pub. L. 92-532) have established a Federal program of marine pollution abatement and control. EPA has issued regulations and criteria (40 CFR 220-227, Appendix VI) to govern the disposal of wastes to the marine environment. EPA controls such disposal by a system of permits for the discharge, transportation, and dumping of all waste materials into the marine environment, except for dredged material which is controlled by the Corps of Engineers, subject to EPA Criteria. Ocean discharge of sludge through outfalls is regulated by EPA under the National Pollutant Discharge Elimination System (NPDES).

3-3.2 Permits. Information available to EPA from permit applications to date indicates that those sludges currently being dumped exceed the criteria and are therefore being dumped under interim permits. One of the conditions of these interim permits is the requirement for an implementation plan to either reduce the toxicity of the materials to meet the criteria or find an alternative method of disposal. Interim permits are granted for one year only and the issuance of new interim permits is based on the progress demonstrated by the permittee on this implementation plan.

3-3.3 Dumping sites. Ocean disposal of sewage sludge is strictly controlled by EPA. Currently EPA will approve only existing dumping sites presently in use for the disposal of particular kinds of waste, unless there is extremely strong evidence in favor of approval of a new location.

[FR Doc.77-31625 Filed 11-17-77; 8:45 am]

Appendix B

- Fishes of the Willamette and Columbia Rivers
- General Life Histories of Common Anadromous Species
- Common Wildlife Species of Northcentral Oregon
- Common Wildlife Species of the Northern Willamette Valley
- Rare, Endangered or Threatened Species Whose Distribution Includes the Study Area

Appendix B

GENERAL LIFE HISTORIES OF COMMON ANADROMOUS SPECIES ENTERING THE COLUMBIA RIVER SYSTEM

SPECIES	TIME OF ENTRY INTO RIVER	TIME OF SPANNING	MAIN SPANNING AREAS	TIME SPENT IN FRESHWATER	TIME OF PEAK DOWNSTREAM MIGRATION OF JUVENILES
Chinook ¹	Feb-May	Aug-Sep	Mountain streams in Idaho, eastern Oregon and Washington and Willamette River	1 year	Feb-Jun
Spring					
Summer	May-Jul	Sep	Salmon River and streams of eastern Washington	3-12 months	Jan-May
Fall	Aug-Sep	Sep-Dec	Main Columbia and lower Columbia tributaries	3 months	Apr-Jun
Coho	Aug-Dec	Oct-Dec	Lower Columbia River tributaries	1 year	Mar-Jun
Sockeye	Jun-Dec	Oct	Washington tributaries	1 year	Apr-Jun
Chum	Nov-Dec	Nov-Dec	Below Bonneville	0	(Jan-Mar) ²
Steelhead ¹					
Winter	Nov-Apr	Dec-Mar	Below Bonneville	1-3 years	Apr-May
Summer	Apr-Oct	Jan-Jul	Tributaries above Bonneville	1-3 years	Aug-Sep
American Shad	May-Jun	Jun-Aug	Willamette and Columbia Rivers	3 months	May-Oct
Smelt	Nov-Feb	Feb-Mar	Below Bonneville	0	(Apr-May)
Green Sturgeon	Aug	Aug	Bays of lower Columbia River	-	-

¹ Downstream migration of juveniles occurs all year

² Parentheses indicate estimate

SOURCE: Oregon Department of Fish and Wildlife (1958, 1971 and 1976)

Appendix B

FISHES OF THE WILLAMETTE AND COLUMBIA RIVERS

Common Name

Scientific Name

Anadromous Game and Nongame Fish

Pacific lamprey
Green sturgeon
American shad
Chum salmon
Coho salmon
Sockeye salmon
Chinook salmon
Steelhead
Eulachon (smelt)

Lampetra tridentata
Acipenser medirostris
Alosa sapidissima
Oncorhynchus keta
Oncorhynchus kisutch
Oncorhynchus nerka
Oncorhynchus tshawytscha
Salmo gairdneri
Thaleichthys pacificus

Resident Game Fish

White sturgeon
Mountain whitefish
Cutthroat trout
Rainbow trout
Golden trout
Black bullhead
Yellow bullhead
Brown bullhead
Channel catfish
Pumpkinseed
Warmouth
Bluegill
Green sunfish
Smallmouth bass
Largemouth bass
White crappie
Black crappie
Yellow perch
Walleye

Acipenser transmontanus
Prosopium williamsoni
Salmo clarki
Salmo gairdneri
Salmo aquabonita
Ictalurus melas
Ictalurus natalis
Ictalurus nebulosus
Ictalurus punctatus
Lepomis gibbosus
Lepomis gulosus
Lepomis macrochirus
Lepomis cyanellus
Micropterus dolomieu
Micropterus salmoides
Pomoxis annularis
Pomoxis nigromaculatus
Perca flavescens
Stizostedion vitreum

Resident Nongame Fish

Western brook lamprey
Chiselmouth
Carp
Goldfish
Oregon chub
Peamouth
Northern squawfish

Lampetra richardson
Acrocheilus alutaceus
Cyprinus carpio
Carassius auratus
Hybopsis crameri
Mylocheilus caurinus
Ptychocheilus oregonensis

Longnose dace
Leopard dace
Speckled dace
Redside shiner
Tench
Largescale sucker
Mountain sucker
Sand roller
Sculpin
Threespine stickleback

Rhinichthys cataractae
Rhinichthys falcatus
Rhinichthys osculus
Richardsonius balteatus
Tinca tinca
Catostomus macrocheilus
Catostomus platyrhynchus
Percopsis transmontanus
Cottus spp.
Gasterosteus aculeatus

SOURCE: Thompson, et al. (1966); W. Pitney (pers. comm., 1977)

Appendix B

COMMON WILDLIFE SPECIES IN NORTHCENTRAL OREGON

Species	Scientific Name	Habitat Type	Seasonal Status ¹
<u>Mammals</u>			
Coyote	<u>Canis latrans</u>	Shrub-steppe	R
Black-tailed jackrabbit	<u>Lepus californicus</u>	Shrub-steppe	R
Deer mouse	<u>Peromyscus maniculatus</u>	Shrub-steppe	R
Black-tailed deer	<u>Odocoileus hemionus</u>	Shrub-steppe	R
<u>Birds</u>			
Western meadowlark	<u>Sturnella neglecta</u>	Shrub-steppe	R
Horned lark	<u>Eremophila alpestris</u>	Shrub-steppe	R
Long-billed curlew	<u>Numenius americanus</u>	Shrub-steppe	SR
Killdeer	<u>Charadrius vociferus</u>	Shrub-steppe	SR
Canada goose	<u>Branta canadensis</u>	Columbia River-agriculture	WR
Mallard	<u>Anas platyrhynchos</u>	Columbia River-agriculture	WR
<u>Reptiles and Amphibians</u>			
Gopher snake	<u>Pituophis melanoleucus</u>	Shrub-steppe	R
Great basin spadefoot	<u>Scaphiopus intermontanus</u>	Shrub-steppe	R

¹ Seasonal Status

R = resident

SR = summer resident

WR = winter resident

Appendix B

COMMON WILDLIFE SPECIES IN THE NORTHERN WILLAMETTE VALLEY

Species	Scientific Name	Habitat Type	Seasonal Status
<u>Mammals</u>			
Black-tailed deer	<u>Odocoileus hemionus</u>	Conifer and hardwood forests	R
Opossum	<u>Didelphis marsupialis</u>	Hardwood forests	R
Striped skunk	<u>Mephitis mephitis</u>	Hardwood forests	R
Raccoon	<u>Procyon lotor</u>	Riparian forests	R
Muskrat	<u>Ondatra zibethica</u>	Stream banks	R
Nutria	<u>Myocastor coypus</u>	Stream banks	R
Townsend's vole	<u>Microtus townsendi</u>	Grassland	R
Black-tailed jackrabbit	<u>Lepus californicus</u>	Grassland	R
<u>Birds</u>			
Golden-crowned sparrow	<u>Zonotrichia atricapilla</u>	Conifer and hardwood forests	SM, FM
Dark-eyed junco	<u>Junco hyemalis</u>	Conifer and hardwood forests	WM
Black-capped chickadee	<u>Parus atricapilla</u>	Conifer and hardwood forests	R
Ruby-crowned kinglet	<u>Regulus calendula</u>	Conifer forests	R
Scrub jay	<u>Aphelocoma coerulescens</u>	Hardwood forests	R
Mourning dove	<u>Zenaida macroura</u>	Agriculture and hardwood forests	SR
Cedar waxwing	<u>Bombycilla cedrorum</u>	Conifer and hardwood forests	SR
Rufous-sided towhee	<u>Pipilo erythrophthalmus</u>	Riparian forests	R
Bewick's wren	<u>Thryomanes bewicki</u>	Riparian forests	R
Willow flycatcher	<u>Empidonax traillii</u>	Riparian forests	SR
Tree swallow	<u>Iridoprocne bicolor</u>	Riparian forests	SR
Osprey	<u>Pandion haliaetus</u>	Riparian forests	R
Great blue heron	<u>Ardea herodias</u>	Riparian forests	R
Western meadowlark	<u>Sturnella neglecta</u>	Grassland	R
Ring-necked pheasant	<u>Phasianus colchicus</u>	Grassland-agriculture	R
Marsh hawk	<u>Circus cyaneus</u>	Grassland	R
Starling	<u>Sturnus vulgaris</u>	Agriculture	R
Common crow	<u>Corvus corax</u>	Agriculture	R
Valley quail	<u>Lophortyx californicus</u>	Riparian and hardwood forests	R
<u>Reptiles and amphibians</u>			
Valley garter snake	<u>Thamnophis elegans</u>	Conifer and hardwood forests	R
Red-legged frog	<u>Rana aurora</u>	Conifer and hardwood forests	R
Red-spotted garter snake	<u>Thamnophis sirtalis</u>	Riparian forests	R
Pacific tree frog	<u>Hyla regilla</u>	Riparian forests	R

Seasonal Status:

R = Resident

SP = Summer Resident

WP = Winter Resident

SM = Spring Migrant

FM = Fall Migrant

Appendix B

RARE, ENDANGERED OR THREATENED WILDLIFE SPECIES WHOSE DISTRIBUTION INCLUDES THE STUDY AREA

Common Name	Scientific Name	Oregon Distribution	Study Area Distribution	Status Federal State
Columbia white-tailed deer	<u>Odocoileus virginianus leucurus</u>	Remnant populations, lower Columbia River floodplain; Roseburg	Possible occurrence on Columbia River islands	E E
American peregrine falcon	<u>Falco peregrinus anatum</u>	Nests eastern Oregon; possibly western Oregon	Possible use of study area for foraging or winter migration	E E
Arctic peregrine falcon	<u>Falco peregrinus tundrius</u>	Possible winter visitor throughout Oregon	Possible foraging flights in winter over study area	E E
Aleutian Canada goose	<u>Branta canadensis leucopareia</u>	Winter migrant; occasional visitor in western Oregon	Possible visitor at Columbia River and Willamette Valley refuges	E E
Northern bald eagle	<u>Haliaeetus leucocephalus alascanus</u>	Nests throughout Oregon; major concentrations in Deschutes and Klamath Counties	Possible use of study area for foraging or winter migration	- T
Western spotted frog	<u>Rana pretiosa</u>	High cascades; eastern Oregon; formerly statewide	Possible occurrence in Columbia and Willamette River basins	- T

SOURCE: Oregon State Department of Fish and Wildlife (1977)

Appendix C
Morrow County Population Projections
Based on ECOAC Scenarios

Appendix C

East Central Oregon Association of Counties - 1977

Scenario A

1. Agriculture - Continued growth in new acreage under irrigation at or near 1970-75 rates until irrigable land (U.S. Bureau of Reclamation data) is consumed. No housing pressure on irrigable land. Agricultural productivity high (no shortages of petroleum-based products); employment growing proportional to new acreage. No shortage of water.
2. Food Processing and Light Industry - Continued growth in food processing and light industry at or near 1970-75 levels.
3. Energy-generation Facilities and Construction - No new electrical-generating plants in area after completion of Carty facility. Construction of second powerhouse at McNary Dam and of I-82 Freeway in Umatilla County to begin in 1980. (Freeway may not be constructed until 1983. Presently uncertain).
4. Other Sectors - Continuation of trends in other sectors of economy at or near 1970-75 rates, including forestry and wood products.
5. Unemployment - See page 202.
6. Heavy Industry - No new heavy industry in area during forecast interval. Alumax aluminum reduction plant not built, nor Pebble Springs Nuclear Plant (as in 3).

Scenario B

1. Same as A.
2. Same as A.
3. In addition to A, construction of two nuclear reactors at Pebble Springs site in Gilliam County beginning in second quarter of 1978. Construction of second plant to begin in 1982. (See page 203).
4. Same as A.
5. Differing as shown on page 202.
6. Construction of Alumax plant to begin in second quarter of 1978. New road north from Ione constructed after 1980.

Scenario C *

1. Same as A and B.
2. Same as A and B.
3. Assumes continued construction of all energy-generating facilities currently projected by Portland General Electric in Morrow and Gilliam Counties and by Pacific Power and Light at Roosevelt, Washington. (See page 202).
4. Same as A and B.

* Note: Scenario B and C are identical for 1980.

CIVILIAN LABOR FORCE PROJECTIONS

Morrow and Umatilla Counties, 1975 - 2000

COUNTY/SCENARIO	1975	1980	1985	1990	1995	2000
<u>UMATILLA - A</u>						
Civilian Labor Force *	21,470	25,600	28,220	30,160	32,010	33,900
Total Employment	19,950	23,940	26,530	28,410	30,250	32,200
Unemployed	1,520	1,660	1,690	1,750	1,760	1,700
Percent	7.1	6.5	6.0	5.8	5.3	5.0
<u>UMATILLA - B</u>						
Civilian Labor Force	21,470	27,700	30,030	32,150	34,820	36,540
Total Employment	19,950	25,980	28,290	30,380	32,970	34,710
Unemployed	1,520	1,720	1,740	1,770	1,850	1,830
Percent	7.1	6.2	5.8	5.5	5.3	5.0
<u>UMATILLA - C</u>						
Civilian Labor Force	21,470	27,700	31,800	33,990	36,430	39,200
Total Employment	19,950	25,980	30,050	32,190	34,610	37,320
Unemployed	1,520	1,720	1,750	1,800	1,820	1,880
Percent	7.1	6.2	5.5	5.3	5.0	4.8
<u>MORROW - A</u>						
Civilian Labor Force	3,310	4,410	5,080	5,240	5,400	5,610
Total Employment	3,130	4,140	4,790	4,950	5,110	5,330
Unemployed	180	270	290	290	290	280
Percent	5.4	6.2	5.8	5.5	5.3	5.0
<u>MORROW - B</u>						
Civilian Labor Force	3,310	5,760	6,050	6,100	6,290	6,570
Total Employment	3,130	5,410	5,720	5,760	5,960	6,240
Unemployed	180	350	330	340	330	330
Percent	5.4	6.0	5.5	5.5	5.3	5.0
<u>MORROW - C</u>						
Civilian Labor Force	3,310	5,760	6,090	6,610	7,070	7,530
Total Employment	3,130	5,410	5,760	6,260	6,720	7,170
Unemployed	180	350	330	350	350	360
Percent	5.4	6.0	5.5	5.3	5.0	4.8

* By place of residence consistent with present Oregon Employment Division Benchmarks.

Portland General Electric, Alumax Pacific Corporation,
and Federal Construction Projects
Morrow, Gilliam, and Umatilla Counties
1975 - 1995 Yearly Average Employment

Project	1975	1980	1985	1990	1995
<u>Portland General Electric</u>	20	1,350	1,600	1,700	1,870
Carty	20	330	100	100	100
Construction	(20)	(230)	--	--	--
Operational	--	(100)	(100)	(100)	(100)
Pebble Springs I *	0	1,020	240	170	170
Construction	--	(1,020)	(90)	--	--
Operational	--	--	(150)	(170)	(170)
Pebble Springs II +	0	0	1,260	170	170
Construction	--	--	(1,260)	--	--
Operational	--	--	--	(170)	(170)
Other (post '85) ++	0	0	0	1,550	1,720
Construction	--	--	--	(1,400)	(1,400)
Operational	--	--	--	(150)	(320)
<u>Alumax *</u>	0	1,750	800	800	800
Construction	--	(1,130)	--	--	--
Operational	--	(620)	(800)	(800)	(800)
<u>Federal</u>	0	500	40	40	40
I-82 **	0	250	20	20	20
Construction	--	(250)	--	--	--
maintenance & patrol	--	--	(20)	(20)	(20)
McNary Powerhouse **	0	250	20	20	20
Construction	--	(250)	--	--	--
Operational	--	--	(20)	(20)	(20)

* Assuming construction to begin, second quarter, 1978.

** Assuming construction to begin, second quarter, 1980.

+ Assuming construction to begin, second quarter, 1982.

++ Assuming construction to begin on third and fourth nuclear plants in area, second quarters of 1986 and 1990.

Appendix D

Emission Rates

- Diesel-Powered Trucks
- Diesel-Powered Vessels

Appendix D

HEAVY DUTY DIESEL EMISSION RATES

<u>Speed (mph)</u>	<u>Speed-Corrected Emission Factors</u> (grams per mile, except as noted)		
	<u>HC</u>	<u>CO</u>	<u>NO_x</u>
Idle	0.40*	0.66*	1.00*
20 mph	4.5	27.0	20.1
25 mph	3.90	21.56	18.79
30 mph	3.47	17.74	18.37
35 mph	3.16	15.04	18.79
40 mph	2.96	13.14	20.10
45 mph	2.83	11.83	22.49
50 mph	2.78	10.98	26.33
55 mph	2.81	10.49	32.24

* grams per minute

No vehicle load/engine power corrections made.

1 gram = 2.2046×10^{-3} pounds

SOURCE: Calculated from data and procedures
presented in U. S. EPA, 1977.
(Mobile Source Emission Factors,
Interim Document, June 1977).

Appendix D

DIESEL VESSEL EMISSIONS FACTORS BY OPERATING MODE^a EMISSION FACTOR RATING: C

Horsepower	Mode	Emissions ^b					
		Carbon monoxide		Hydrocarbons		Nitrogen oxides (NO _x as NO ₂)	
		lb/10 ³ gal	kg/10 ³ liter	lb/10 ³ gal	kg/10 ³ liter	lb/10 ³ gal	kg/10 ³ liter
200	Idle	210.3	25.2	391.2	46.9	6.4	0.8
	Slow	145.4	17.4	103.2	12.4	207.8	25.0
	Cruise	126.3	15.1	170.2	20.4	422.9	50.7
	Full	142.1	17.0	60.0	7.2	255.0	30.6
300	Slow	59.0	7.1	56.7	6.8	337.5	40.4
	Cruise	47.3	5.7	51.1	6.1	389.3	46.7
	Full	58.5	7.0	21.0	2.5	275.1	33.0
500	Idle	282.5	33.8	118.1	14.1	99.4	11.9
	Cruise	99.7	11.9	44.5	5.3	338.6	40.6
	Full	84.2	10.1	22.8	2.7	269.2	32.3
600	Idle	171.7	20.6	68.0	8.2	307.1	36.8
	Slow	50.8	6.1	16.6	2.0	251.5	30.1
	Cruise	77.6	9.3	24.1	2.9	349.2	41.8
700	Idle	293.2	35.1	95.8	11.5	246.0	29.5
	Cruise	36.0	4.3	8.8	1.1	452.8	54.2
900	Idle	223.7	26.8	249.1	29.8	107.5	12.9
	2/3	62.2	7.5	16.8	2.0	167.2	20.0
	Cruise	80.9	9.7	17.1	2.1	360.0	43.1
1550	Idle	12.2	1.5	—	—	39.9	4.8
	Cruise	3.3	0.4	0.64	0.1	36.2	4.3
	Full	7.0	0.8	1.64	0.2	37.4	4.5
1580	Slow	122.4	14.7	—	—	371.3	44.5
	Cruise	44.6	5.3	—	—	623.1	74.6
	Full	237.7	28.5	16.8	2.0	472.0	5.7
2500	Slow	59.8	7.2	22.6	2.7	419.6	50.3
	2/3	126.5	15.2	14.7	1.8	326.2	39.1
	Cruise	78.3	9.4	16.8	2.0	391.7	46.9
	Full	95.9	11.5	21.3	2.6	399.6	47.9
3600	Slow	148.5	17.8	60.0	7.2	367.0	44.0
	2/3	28.1	3.4	25.4	3.0	358.6	43.0
	Cruise	41.4	5.0	32.8	4.0	339.6	40.7
	Full	62.4	7.5	29.5	3.5	307.0	36.8

^aReference 2.

^bParticulate and sulfur oxides data are not available.

SOURCE: U. S. EPA - Compilation of air pollutant emission factors. AP-42, Part A, second edition.

Appendix E
Archeological Survey

Department of
Anthropology

9 February 1978



Corvallis, Oregon 97331 (503) 754-4515

TO: Jonathan Ives
Jones and Stokes Associates

FROM: Glenn Hartmann

SUBJECT: Archaeological Surveys for the sludge disposal project,
City of Portland.

Archaeological fieldwork has recently been completed for pipelines and dock sites outlined in your letter of 18 January. As we discussed on the phone, survey of disposal areas awaits further decisions for selection of the final disposal site.

No prehistoric archaeological sites were discovered during survey. Sites which existed at the mouths of Threemile and Sixmile Canyons were destroyed during reservoir construction and/or inundated by the raising of Lake Umatilla. The surface of the Multnomah County dock site was quite disturbed and covered with dredge spoils. The pipeline route in Portland was likewise disturbed.

Reconnaissance of pipeline alternatives in Morrow County was somewhat hampered as I had difficulty locating the precise pipeline routes. However, there are no surface indicators of archaeological sites in any of the pipeline corridors. There is one area which has some potential for containing a buried site. This is the sheep camp in SE 1/4 Section 23, Township 4N, Range 23E. Survey of the bench on which the camp is located was all but impossible due to pens full of lambing sheep, hostile dogs, and less than hospitable shepherds. I spoke with one individual who said he'd never found any archaeological materials, but that is no guarantee that a site does not exist there. I would say that chances for a buried site there are possible, but remote.

Several stone "cairns" were noted in the course of survey, but none seem to be in the proposed pipeline routes. Interpretation of these phenomena has been a long-standing problem in the Northwest as it is difficult to ascertain whether they are prehistoric or historic structures. Based on previous experience I would say that the cairns I observed were historic. They are not eligible for the National Register.

I also noted the remains of an old cabin in Section 28 at a considerable distance from the pipeline route. The remains of stone footings,

page two
9 February 1978

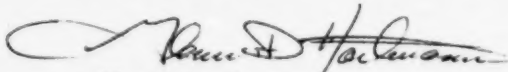
rusted cans, broken pottery and cast iron stove parts were evident. This site will not be impacted by the present project. It is also not of National Register quality.

The State Historic Preservation Office in Salem was consulted. As previously mentioned, there were archaeological sites along the Columbia River in Morrow County presumable at the canyon mouths. The sites are now inundated or destroyed as a result of reservoir construction. There are no National Register Sites in the project area.

I briefly looked over the alternative disposal sites in Morrow County. Based on that quick look and on topographic map examination it appears that there is equally low site likelihood for the three disposal areas. Still, there should be an archaeological survey of the final site chosen as it is possible that archaeological resources are located there.

The final report for this survey is now being prepared. If I can be of further assistance in the interim, please call me.

Sincerely,

A handwritten signature in dark ink, appearing to read "Glenn D. Hartmann", with a stylized flourish at the end.

Glenn D. Hartmann
Contract Archaeologist

Appendix F

Detailed Cost Analysis for Alternatives A-1, C-1, D-1, D-2 and No Action

Construction cost estimates in this Appendix are based upon conceptual designs for each of the alternatives. In most cases, the costs are identical to those presented in the City of Portland's Facility Plan, although some changes were made on the basis of more recent data and the author's experience in cost estimating and actual plant construction bids. All construction costs are presented in December 1977 dollars, which is equivalent to an EPA Construction Cost Index of 152 for the City of Portland.

Operation and maintenance cost estimates were made on the basis of labor, electrical, fuel and material requirements. Unit costs for labor, electrical and fuel requirements were:

Labor - \$11.00/hr (average loaded rate)

Energy - \$ 0.01/kwh (electricity, including load factor)

Fuel - \$ 1.90/tcf (natural gas)

Material requirements were adjusted to December 1977 costs using a Wholesale Price Index for the City of Portland of 11.98.

Sewerage system construction costs are directly dependent upon material and labor costs as well as the climate for competitive bidding at the time of advertising for proposals from contractors. The projection of future costs is also speculative due to the widely fluctuating inflation rates of recent years. However, an acceptable inflation rate is about 8 percent for construction and 6 percent for operation and maintenance, based on various published forecasts. The projection of future construction costs can therefore be estimated by using the compound interest formula below.

$$\text{Future cost} = \text{present cost} \times (1 + i)^n$$

where n = number of years from December 1977 to
mid-point of construction

i = inflation rate assumed as a decimal

The cost analysis for each Alternative includes a worth analysis, as mandated by federal regulations, as well as an analysis of the annual cost to the community. The interest rate to be used for the present worth analysis is specified by the Water Resources Council and is 6 5/8 percent for fiscal year 1978. For local costs, an interest rate of 7 percent is assumed since it is more appropriate for financing by the City of Portland.

The present worth value may be defined as the amount that must be invested at a specified interest rate, at the start of a project, to provide funds sufficient to meet annual expenditures during the life of the project. The resulting value provides a "one number" way of comparing the total costs of all the alternatives.

Alternative A-1 - Land Application in Eastern Oregon. The total capital costs for Alternative A-1 are \$16,329,000 and the average annual operation and maintenance costs are \$1,362,200 as shown in Table F-1. On the basis of these costs, total annual cost would be \$2,903,400, or \$99.40 per ton of dry sludge. However, on a local share cost basis, the average unit cost per ton of dry sludge solids is only \$59.90 per ton, as shown in Table F-2. Table F-3 presents the costs for each year between 1978 and 2000. The total present worth of the costs over this period is \$27,598,400.

Alternative C-1 - Sludge Drying System. The total capital costs for Alternative C-1 are \$15,015,000 and the average annual operation and maintenance costs are \$1,507,000 as shown in Table F-4. Based on these costs, total annual cost would be \$2,924,400 or \$100.20 per ton of dry sludge. However, on a local share cost basis, the average unit cost per ton of dry sludge solids is only \$58.80 per ton, as shown in Table F-5. Table F-6 presents costs for each year between 1978 and 2000. The total present worth of the costs over this period is \$26,573,800.

Alternative D-1 and D-2. The total capital costs for Alternatives D-1 and D-2 are \$17,272,600 and \$21,117,400, respectively, and the average annual operation and maintenance costs are \$1,857,300 and \$2,104,500, respectively, as shown in Table F-9. Based on these costs, total annual cost would be \$3,487,700 for D-1 and \$4,097,800 for D-2 or \$119.40 and \$140.30, respectively, per ton of dry sludge. However, on a local share cost basis, the average unit cost per ton of dry sludge solids for D-1 is only \$82.30 per ton, as shown in Table F-10. Table F-10 presents the costs for each year between 1978 and 2000 for D-1. Total present worth of the costs over this period is \$30,507,100.

No-Action Alternative. Capital cost for no action would only be for cleaning of the Triangle Lake Lagoon, or \$1,816,000. The annual operation and maintenance cost, based on 55 tons of sludge per day, would be \$404,900. The total annual cost would be \$576,300, which is equivalent to \$28.70 per ton, or a local share cost of \$22.30 per ton.

Table F-1

ESTIMATED TOTAL ANNUAL COSTS

Alternative A-1 - Land Application in Eastern Oregon

<u>Process</u>	<u>Capital Costs (\$1,000's)</u>	<u>Amortized Capital Costs (\$1,000's)</u>	<u>O&M Costs (\$1,000's)</u>	<u>Total Annual Costs (\$1,000's)</u>
Digestion	8,100.0	764.6	259.0	1,023.6
Lagoon Storage	1,816.0	171.4	57.0	228.4
Barge Loading Dock	780.0	73.6	76.0	149.6
Transportation & Land Application	2,775.0	261.9	983.0	1,244.9
Electric Generating Equipment	2,188.0	206.5	96.0	302.5
Credit for Digester Gas	-	-	(157.8)	(157.8)
Sludge Pumping & Forcemain	<u>670.0</u>	<u>63.5</u>	<u>49.0</u>	<u>112.2</u>
TOTALS	16,329.0	1,541.2	1,362.2	2,903.4 ¹

¹ Average cost per ton is \$99.4

Table F-2

ESTIMATED LOCAL ANNUAL COSTS

Alternative A-1 - Land Application in Eastern Oregon

<u>Year</u>	<u>Capital Costs (\$1,000's)</u>	<u>O&M Costs (\$1,000's)</u>	<u>Annual Costs¹ (\$1,000's)</u>
1978			
1979			
1980			
1981	385.3	1,362.2	1,747.5
1982			
1983			
1984			
1985			
1986			
1987			
1988			
1989			
1990			
1991			
1992			
1993			
1994			
1995			
1996			
1997			
1998			
1999			
2000	385.3	1,362.2	1,747.5

¹ Average unit cost per ton is \$59.9

Table F-3

PRESENT WORTH COSTS

Alternative A-1 - Land Application in Eastern Oregon

<u>Year</u>	<u>Capital Costs (\$1,000's)</u>	<u>O&M Costs (\$1,000's)</u>	<u>Annual Costs (\$1,000's)</u>
1978	1,306.3		1,306.3
1979	8,164.5		8,164.5
1980	6,858.2		6,858.2
1981		1,362.2	1,362.2
1982			
1983			
1984			
1985			
1986			
1987			
1988			
1989			
1990			
1991			
1992			
1993			
1994			
1995			
1996			
1997			
1998			
1999		↓	1,362.2
2000	-5,443.0	1,362.2	-4,080.8

P.W. Capital = \$12,736,900; P.W. O&M = \$14,861,500

Total P.W. = \$27,598,400

Table F-4

ESTIMATED TOTAL ANNUAL COSTS

Alternative C-1 - B.E.S.T. Sludge Drying System

<u>Process</u>	<u>Capital Costs (\$1,000's)</u>	<u>Amortized Capital Costs (\$1,000's)</u>	<u>O&M Costs (\$1,000's)</u>	<u>Total Annual Costs (\$1,000's)</u>
Digestion	8,100.0	764.6	259.0	1,023.6
Lagoon Storage	1,488.5	140.5	-	140.5
Vacuum Filtration	-	-	293.0	293.0
B.E.S.T. Drying System	5,427.0	512.3	1,218.0	1,730.3
Credit for Reclaimed Oil	-	-	(30.0)	(30.0)
Credit for Digester Gas	-	-	(263.0)	(263.0)
TOTALS	15,015.5	1,417.4	1,507.0	2,924.4 ^{1, 2}

¹ Average cost per ton is \$100.2

² Costs for disposal and/or sale of product are not included

Table F-5

ESTIMATED LOCAL ANNUAL COSTS

Alternative C-1 - B.E.S.T. Sludge Drying System

<u>Year</u>	<u>Capital Costs (\$1,000's)</u>	<u>O&M Costs (\$1,000's)</u>	<u>Annual Costs¹ (\$1,000's)</u>
1978			
1979			
1980			
1981	354.4	1,507.0	1,861.4
1982			
1983			
1984			
1985			
1986			
1987			
1988			
1989			
1990			
1991			
1992			
1993			
1994			
1995			
1996			
1997			
1998			
1999			
2000	354.4	1,507.0	1,861.4

¹ Average unit cost per ton is \$63.75.

Table F-6

ESTIMATED TOTAL ANNUAL COSTS

Carver-Greenfield Process Alternative

Process	Capital Costs (\$1,000's)	Amortized Capital Costs (\$1,000's)	O&M Costs (\$1,000's)	Total Annual Costs (\$1,000's)
Digestion	8,100.0	764.6	259.0	1,023.6
Lagoon Storage	1,488.5	140.5	-	140.5
Centrifuging				
Carver-Greenfield Process	6,333.0	597.8	675.2	1,273.0
Electrical				
Generating				
Equipment	2,188.0	206.5	96.0	302.5
Credit for Digester	-	-	(263.0)	(263.0)
TOTALS	18,109.5	1,709.4	767.2	2,476.6 ^{1, 2}

¹ Costs for disposal and/or sale of product are not included

² Average cost per ton is \$84.8

Table F-7

ESTIMATED LOCAL ANNUAL COSTS

Carver-Greenfield Process Alternative

<u>Year</u>	<u>Capital Costs (\$1,000's)</u>	<u>O&M Costs (\$1,000's)</u>	<u>Annual Costs¹ (\$1,000's)</u>
1978			
1979			
1980			
1981	427.3	767.2	1,194.5
1982			
1983			
1984			
1985			
1986			
1987			
1988			
1989			
1990			
1991			
1992			
1993			
1994			
1995			
1996			
1997			
1998			
1999			
2000	427.3	767.2	1,194.5

¹ Average unit cost per ton is \$40.90

Table F-8

PRESENT WORTH COST

Alternative C-1 - Sludge Drying System

<u>Year</u>	<u>Capital Costs (\$1,000's)</u>	<u>O&M Costs (\$1,000's)</u>	<u>Annual Costs (\$1,000's)</u>
1978	1,201.2		1,201.2
1979	7,507.7		7,507.7
1980	6,306.5		6,306.5
1981		1,507.0	1,507.0
1982			
1983			
1984			
1985			
1986			
1987			
1988			
1989			
1990			
1991			
1992			
1993			
1994			
1995			
1996			
1997			
1998			
1999		1,507.0	1,507.0
2000	-5,005.2	1,507.0	-3,498.2

P.W. Capital = \$11,712,300; P.W. O&M = \$16,441,300

Total P.W. = \$28,153,600

Table F-9

ESTIMATED TOTAL ANNUAL COSTS

Alternative D-1 and D-2
Land Application in Willamette Valley

Process	Capital Costs (\$1,000's)	Amortized Capital Costs (\$1,000's)	O&M Costs (\$1,000's)	Total Annual Costs (\$1,000's)
Digestion	8,990.0	848.6	287.5	1,136.1
Lagoon Storage	1,816.0	171.4	57.0	228.4
Lagoon Storage at Destination	2,443.4	230.6	93.6	324.2
Land Application	419.1	39.6	235.0	274.6
Electrical Generating Equipment	2,188.0	206.5	96.0	302.5
Credit for Digester Gas	-	-	(157.8)	(157.8)
TRUCK TRANSPORT SYSTEM ¹				
Truck Transport	1,416.1	133.7	1,246.0	1,379.7
BARGE TRANSPORT SYSTEM ¹				
Pumping & F/M	670.0	63.2	49.0	112.2
Barge Loading				
Docks (2)	1,093.5	103.2	88.4	191.6
Barge Transport	1,714.0	161.8	946.4	1,108.2
Unloading Dock	435.0	41.1	46.8	87.9
Pumping to Storage Lagoon	930.0	87.8	35.0	122.8
Truck Transport	418.4	39.5	327.6	367.1
TOTAL WITH TRUCK TRANSPORT	17,272.6	1,630.4	1,857.3	3,487.7 ¹
TOTAL WITH BARGE TRANSPORT	21,117.4	1,993.3	2,104.5	4,097.8 ²

¹ Average cost per ton is \$119.4

² Average cost per ton is \$140.3

³ Costs are based on minimum distances computed from the Columbia Boulevard STP to the northwesternmost portion of the proposed sludge application area. Transportation costs would be greater for sludge spreading farther south.

Table F-10

ESTIMATED LOCAL ANNUAL COSTS

Alternative D-1 - Land Application in Willamette Valley

<u>Year</u>	<u>Capital Costs (\$1,000's)</u>	<u>O&M Costs (\$1,000's)</u>	<u>Annual Costs¹ (\$1,000's)</u>
1978			
1979			
1980			
1981	408.1	1,372.7	1,780.8
1982			1,780.8
1983			
1984	408.1	1,372.7	
1985	753.5	1,857.3	2,610.8
1986	↓	↓	↓
1987			
1988			
1989			
1990			
1991			
1992			
1993			
1994			
1995			
1996			
1997			
1998	↓	↓	↓
1999			
2000	753.5	1,857.3	2,610.8

¹ Average unit cost per ton is \$82.3

Table F-11

PRESENT WORTH COSTS

Alternative D-1 - Land Application in Willamette Valley

<u>Year</u>	<u>Capital Costs (\$1,000's)</u>	<u>O&M Costs (\$1,000's)</u>	<u>Annual Costs (\$1,000's)</u>
1978	1,381.8		1,381.8
1979	8,636.3		8,636.3
1980	7,254.5		7,254.5
1981		1,372.7	1,372.2
1982			
1983			
1984		1,372.7	1,372.7
1985	1,677.3	1,857.3	3,534.6
1986			1,857.3
1987			
1988			
1989			
1990	1,677.3		1,857.3
1991			3,534.6
1992			1,857.3
1993			
1994			
1995	1,677.3		1,857.3
1996			3,534.6
1997			1,857.3
1998			
1999			
2000	-5,757.5	1,857.3	1,857.3
			-3,900.2

P.W. Capital = \$15,870,300; P.W. O&M = \$14,636,800
 Total P.W. = \$30,507,100

Table F-12

ESTIMATED TOTAL ANNUAL COSTS

No Action Alternative

<u>Process</u>	<u>Capital Costs (\$1,000's)</u>	<u>Amortized Capital Costs (\$1,000's)</u>	<u>O&M Costs (\$1,000's)</u>	<u>Total Annual Costs (\$1,000's)</u>
Digestion-aerobic	-	-	111.7	111.7
Digestion-anaerobic	-	-	50.0	50.0
Lagoon Storage	1,816.0	171.4	57.0	228.4
Transportation	-	-	93.1	93.1
Land Application	-	-	93.1	93.1
TOTALS	1,816.0	171.4	404.9	576.3 ¹

¹ Average total cost per ton is \$28.7 based on 55 tons per day production and average local cost is \$22.3.

Appendix G

Energy Analysis for Alternatives

A-1, C-1, D-1, and D-2

Sludge treatment and disposal systems consume and produce energy in a variety of forms. For the alternatives considered, energy may be used as electrical energy, fuel oil, or natural gas. Production of digester gas is also a consideration in the overall energy balance. To be able to compare energy consumption of the various alternatives, all energy/consumption, regardless of its form, is equated to electrical energy. The conversion factors utilized were:

1 gallon of #2 Motor Fuel = 40 kilowatt hours

1,000,000 British Thermal Units (M BTU's) = 293 kilowatt hours

1 cubic foot of natural gas = 1,000 BTU's

1 cubic foot of digester gas = 566 BTU's

Alternative A-1 utilizes energy for digester heating, sludge pumping, and barge transport. Overall however, when digester gas production is included, the alternative is a net energy generator. As shown in Table G-1, a net energy surplus of 110,600 kilowatt hours per day would result from implementation of Alternative 1.

In Alternative C-1, energy is utilized for digester heating, vacuum filtration, and operation of the B.E.S.T process. Produced energy, on the other hand, is from digester gas production and reclaimed oil produced in the B.E.S.T. process. Overall, the process is nearly self sustaining, with a net energy consumption of 900 kilowatt hours per day.

In Alternative D-1 and D-2, which are truck transport and barge transport, respectively, to the Willamette Valley, energy is required for digester heating and transportation. Production of energy is in the form of digester gas. Overall, both Alternatives are energy producers, Alternatives D-1 and D-2 having surpluses of 64,500 and 81,000 kilowatt hours per day, respectively.

Table G-1
ENERGY CONSUMPTION

Alternative A-1 - Land Application in Eastern Oregon

Process	Energy Consumption (1000 kwh/day)
Digester Heating	54.9
Sludge Pumping	0.3
Barge Transport	36.3
Digester Gas Produced	<u>(165.8)</u>
Energy Consumed In-Plant (Surplus)	(110.6)

Table G-2

ENERGY CONSUMPTION

Alternative C-1 - Sludge Drying System

<u>Process</u>	<u>Energy Consumption (1000 kwh/day)</u>
Digester Heating	54.9
BEST Heating	111.9
BEST Electrical	30.0
Vacuum Filters	3.8
Digester Gas Produced	(165.8)
Reclaimed Oil ¹	<u>(34.9)</u>
Energy Consumed in Plant (Surplus)	(0.1)
Natural Gas Make-up for BEST Process	1.0

¹ This reclaimed oil represents potentially usable energy only.

Table G-3
ENERGY CONSUMPTION
Carver-Greenfield Process Alternative

<u>Process</u>	<u>Energy Consumption (1000 kwh/day)</u>
Digester Heating	54.9
Carver-Greenfield Process	14.6
Digester Gas Produced	(<u>165.8</u>)
Energy Consumed In-Plant (Surplus)	(96.3)

Table G-4

ENERGY CONSUMPTION

Alternatives D-1 and D-2 -
Land Application in Willamette Valley

<u>Process</u>	<u>Energy Consumption (1000 kwh/day)</u>
Digester Heating	54.9
Alternative D-1	
Truck Transportation	46.4
Alternative D-2	
Sludge Pumping ¹	0.9
Barge Transportation ¹	24.2
Truck Transportation ¹	4.8
Digester Gas Produced	<u>(165.8)</u>
Energy Consumed in Plant (Surplus)	(110.9)
Overall Energy Balance Alternative D-1	(64.5)
Overall Energy Balance Alternative D-2	(81.0)

¹ These energy consumption estimates are based on minimum distance from the Columbia Boulevard STP to the northern Willamette Valley.

Appendix H

Letter of Interest

Boeing Agri-Industrial Company

BOEING
AGRI-INDUSTRIAL COMPANY

P.O. BOX 97
BOARDMAN, OREGON 97818
TELEPHONE (503) 481-2281

April 26, 1978

Mr. J. P. Niehuser
Chief Civil Engineer
Department of Public Works
CITY OF PORTLAND
400 S.W. Sixth Avenue
Portland, OR 97240

Dear Mr. Niehuser:

The following information is submitted in reply to your letter of April 3, 1978.

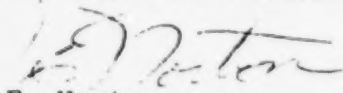
Boeing Agri-Industrial Company is interested in submitting a proposal for the leasing of land areas to the City of Portland for use as a soil improvement site utilizing stabilized waste-water sludge as a soil conditioner. As of this date the amount of land required for the operation has not been established; however, I believe sufficient land in suitable locations is available for that purpose. Availability of land, however, is contingent upon prior leasing by other parties for agricultural purposes.

We recognize that various operational facilities will be required near the waterfront as well as farther inland. Any participation in the provisioning or operation of any of the facilities would, of necessity, be a matter for study and consideration after such items have been more clearly defined.

We are interested in assisting in making the soil improvement project a reality and a successful endeavor, however, further information is necessary before we can make firm commitments.

Very truly yours,

BOEING AGRI-INDUSTRIAL COMPANY


V. E. Norton
Vice President

Appendix I. City of Portland

Ordinance No. 146547

An Ordinance accepting the recommendation of the City Engineer for a long term sludge disposal method; authorizing the City Engineer to negotiate for purchase of land and easements; authorizing application for a \$369,675 grant from the U. S. Environmental Protection Agency; authorizing an agreement with the U. S. Environmental Protection Agency; designating an authorized grant representative; authorizing the Commissioner of Public Works to make certain assurances, and declaring an emergency.

The City of Portland ordains:

Section 1. The Council finds:

1. Ordinance No. 143406, passed by Council April 6, 1977, directed the City Engineer to present a recommendation to the Council concerning the final method for disposal of sewage sludge by January, 1979.
2. An outline of studies conducted in relation to long term methods for sludge disposal, the alternatives and the City Engineer's recommendation are contained in a memorandum to the Mayor and the Commissioners, dated September 1, 1978, marked "Exhibit A" attached.
3. It is the recommendation of the City Engineer that the City of Portland should proceed with the design of facilities for barging digested sludge to Eastern Oregon for land application as a soil conditioner.
4. The Commissioner of Public Works has reviewed and approves the above recommendation.
5. The Federal Water Pollution Control Act Amendments of 1972, Public Law 92-500 authorizes the administrator of the Environmental Protection Agency to make grants-in-aid to local governments to share in the cost of design and construction of wastewater treatment works.
6. The Environmental Protection Agency will, if a grant is approved pay 75% or \$369,675 of the estimated cost of \$492,900 for preparation of engineering plans and specifications for construction of facilities for transportation and disposal of sewage sludge in Eastern Oregon.
7. That it is appropriate that the City make application for such a grant, and if the grant is approved, execute an agreement with the Environmental Protection Agency.
8. That it is necessary for the Commissioner of Public Works to provide certain assurances and that it is a requirement of the Federal government that an authorized representative for the City of Portland be appointed by the Council and be a full time employee of the City.

ORDINANCE No.

NOW, THEREFORE, the Council directs:

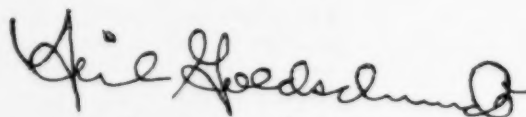
- a. The City Engineer is hereby authorized to proceed with engineering and other activities necessary for implementing the recommendation of barge transportation and land application of digested sludge in Eastern Oregon.
- b. The City Engineer is further authorized to negotiate for purchase of easements and lands necessary, or as other ways may more appropriately effectuate the intent of this ordinance in order to accomplish the project, such purchases subject to Council acceptance and authorization of payment.
- c. The Mayor and the Commissioner of Public Works are hereby authorized to make application to the U. S. Environmental Protection Agency for a grant-in-aid for \$369,675 for preparation of plans and specifications for the necessary transportation and disposal facilities and should said grant be approved, an agreement is hereby authorized.
- d. The City Engineer of Portland, Oregon, Cowles Mallory, is hereby designated as the City of Portland's authorized representative for all administrative matters in relation to the said grant application and subsequent agreement.
- e. The Commissioner of Public Works is hereby authorized to give assurance to the U. S. Environmental Protection Agency that the City will comply with Title VI of the Civil Rights Act of 1964 and the regulations of the U. S. Environmental Protection Agency effectuating that title providing that no persons shall be discriminated against because of race, color or national origin in the award of contract for construction of said facilities.
- f. The Commissioner of Public Works is hereby authorized to give the U. S. Environmental Protection Agency such information and assurances as may be required by the Agency and the State of Oregon for their consideration of said grant.

Section 2. The Council declares that an emergency exists because there is an immediate need to implement the recommended sludge disposal program, therefore, this Ordinance shall be in full force and effect from and after its passage by the Council.

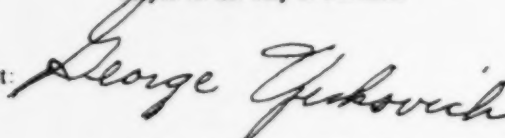
Passed by the Council, SEP 27 1978

Commissioner Connie McGready
September 21, 1978
BUC 14621717
JTK

Attest:



Mayor of the City of Portland



Auditor of the City of Portland



"EXHIBIT A"

September 1, 1978

MEMORANDUM

DEPARTMENT OF
PUBLIC WORKS
CONNIE MCCREADY
COMMISSIONER

OFFICE OF
PUBLIC WORKS
ADMINISTRATOR

100 S.W. SIXTH AVE.
PORTLAND, OH. 97204

TO: Mayor Neil Goldschmidt
Commissioner Connie McCreedy
Commissioner Frank Ivancie
Commissioner Charles Jordan
Commissioner Mildred Schwab

FROM: Cowles Mallory *Cowles*
Public Works Administrator

SUBJECT: Sludge Disposal

On September 20 the City Council will be asked to consider an ordinance authorizing design and construction of facilities to provide a long term solution to the problems of wastewater sludge disposal. Presented below is an outline of the history, the alternatives, and our recommendations.

History

The City originally planned to construct an incinerator for disposal of sewage sludge. In June 1975 the City Council decided to re-evaluate this decision and approved a study of alternative disposal methods.

In March 1977 City staff completed a report entitled "Alternative Methods for the Disposal of Sewage Solids." All known processes were reviewed and the following sludge disposal alternatives evaluated in detail: land utilization of digested sludge in eastern and western Oregon, composting for land utilization, incineration with landfill disposal of ash, and sludge drying for local marketing or landfill disposal. Several variations and combinations of these methods were also considered.

On April 6, 1977 the City Council narrowed the choice of disposal alternatives to 1) transporting digested sludge by barge to eastern Oregon for application to land, or 2) drying digested sludge for local marketing. The Council also authorized design of additional sludge digesters and rebuilding of the sewage lagoon, facilities which would be used with either alternative. The final selection of a disposal method was scheduled

for January 1979 to allow time for a) sludge drying pilot plant work, b) completion of the regional sludge disposal study conducted by the U. S. Army Corps of Engineers for CRAG, and c) clarification of state and federal regulations for land application of sludge.

Design of both the digesters and the lagoon will be finished in October. Construction of the lagoon is scheduled for completion in May 1980 and the digesters will be operational in May 1981.

In November 1977 the Environmental Protection Agency (EPA) decided to prepare an environmental impact statement (EIS) for City of Portland sludge disposal alternatives. During preparation of the EIS, public meetings were held in Boardman, Oregon City and Portland. A final public hearing was conducted by EPA in Portland on July 21, 1978. Copies of EPA's draft environmental impact statement and public comments received are enclosed.

Both the Corps study and EPA's draft EIS confirm the results of the March 1977 City study.

EPA has now requested a City decision on sludge disposal for inclusion in the final EIS. We believe sufficient information is available to make that decision.

Alternatives

Two alternatives remain in consideration; barging and drying.

Barging. Digested sludge would be pumped to barges on the Columbia River, transported up river to Boardman, and used as a soil conditioner. The sludge would be applied to the land as a liquid.

Drying. Digested sludge would be dried with a proprietary system developed by the Resources Conservation Company. The process uses chemicals and heat to extract water from the sludge. The dried sludge would then be used locally as a soil conditioner.

Both the barging and the drying alternatives are variations of land disposal. They differ only in the type and extent of processing and the disposal location.

As a result of the three separate studies, we are convinced that either alternative would be acceptable to the City and that they are the two best alternatives for City consideration. We are also convinced that we have delineated the best sludge drying method now commercially available and have delineated the best combination of transportation and location for land application of liquid sludge.

The following factors were considered in analyzing these alternatives. Detailed analysis of these factors are found in both the March 1977 City staff report, previously submitted to your office, and the attached draft EIS prepared by EPA.

- A. Cost. Within the accuracy of the report, the two alternatives are cost-equivalent. The City study and the EPA study show a 10% and 6% advantage, respectively, for barging. The Corps study shows a 2% advantage for drying. The accuracy of the reports are minus 15% to plus 30%.

The value assigned to the product in the drying alternative accounts for part of the difference in the study results. In both the City and the EPA study, costs for the drying alternative assume that the dried product will have market value equal to the transportation cost of removing it from the treatment plant. The Corps study assumes a net value for the dry product of \$20.00 per ton after all marketing and transportation costs. The marketability study conducted in conjunction with the EPA report shows that the market value of the dry product would decrease the total cost of the drying process by approximately 7% before marketing and transportation costs are considered. A copy of this marketing study is attached. It is possible that with an aggressive marketing program the value of the product would increase, thus reducing the overall cost of the drying alternative.

Costs for the barging alternative assume a continuation of current federal policy for the use of navigable waterways. If substantial charges are imposed for use of the locks, the cost of this alternative will increase.

- B. Environmental Effects. Both alternatives are environmentally acceptable. Barging has a minor environmental risk of water pollution resulting from a barge accident. Drying has a minor environmental risk of odors resulting from equipment failure. Otherwise, the alternatives are environmentally equivalent.

- C. Regulations. Both alternatives have the disadvantage of uncertainty with regard to future state and/or federal regulations governing the application of wastewater solids to agricultural land.
- D. Energy. Barging has an overall energy surplus of 247 million BTU's per day. Drying has a slight energy deficit. Barging is primarily a user of diesel fuel. Drying is primarily a user of electric and digester gas energy.
- E. Chemical Use. The use of petroleum base chemicals constitutes 11% of the cost of the drying alternative. The barging alternative uses no chemicals.
- F. Reliability. The barging alternative uses simple equipment and no new technology. The individual elements of the barging alternative contain nothing that has not been successfully done for at least fifty years. The drying alternative is more equipment-intensive and has not been previously used in a full scale operation. Resources Conservation Company did conduct a successful pilot plant operation at the Columbia Boulevard Treatment Plant. They have also successfully installed another unproven process of their own design for removing inorganic solids from power plant wastewaters.
- G. Beneficial Use. Both alternatives use the sludge for a soil conditioner/fertilizer. Barging removes the product to eastern Oregon. Drying retains the product for use in the Portland metropolitan area.

Recommendation

We recommend that the City Council select the barging alternative. We base our judgment primarily on the relative simplicity and proven reliability of sludge pumping, barge transportation and land application systems.

If the Council wishes to aggressively pursue the retention of the sludge for use in the metropolitan area, we believe the drying alternative is an acceptable risk. In order to develop a good market, the City would have to commit to an extensive marketing program.

In either case, it is anticipated that engineering plans and specifications will be completed by March 1980, that construction will commence by December 1980, and that the facilities will be fully operational by July 1983.

We would appreciate an opportunity to review our recommendations with you or members of your staff prior to the official Council meeting. If you have any questions concerning the report, please call me (4103) or Dale Nunamaker, our Project Engineer (4213).

CM:jd

cc: Public Works Citizen Advisory Committee

COMMENTS AND RESPONSES TO THE DRAFT EIS

This section contains letters of comments from agencies, individuals and groups on the Draft EIS. Those letters which commented directly upon the Draft EIS have been reproduced in this section. Wherever a response is required by EPA to the letter, a response page follows that letter.

Table 31 is a listing of the comment letters received during the 45-day review period, including a general category listing of their contents. Comment categories are shown in an attempt to indicate those aspects of the proposed project about which the commenters were most interested and concerned. This may serve to direct the reader to those sections of the document which he may wish to restudy.

In addition to many public meetings on the proposed project EPA held a public hearing in Boardman, Oregon on July 20, 1978 and Portland, Oregon on July 21, 1978. The hearing in Boardman was attended by approximately five people, one of which commented on the Draft EIS. The hearing in Portland was attended by approximately 21 people, three of which read testimony into the official record. A question and answer session, after agency presentations and oral testimony, was a part of each hearing and is included in the hearing record. Because of the length of the official hearing record and the costs involved we have not reproduced the document for the Final EIS. Table 32 is provided, however, listing the speakers and the areas in which they provided comments. A summary of the testimony follows the public hearing table. The public hearing record is available for public scrutiny at EPA's Oregon Operations Office in Portland, Oregon and EPA's Region 10 Office in Seattle, Washington.

The EPA wishes to express its appreciation to all commenting agencies, groups and individuals for the time and effort spent in reviewing the Draft EIS. All comments were fully considered prior to formulating EPA's recommended proposed action.

Table 31

Date Received	Comment Received on Draft Environmental Impact Statement From	FEDERAL POLICY	ENERGY	SLUDGE MARKET	AGRICULTURE	GROUNDWATER	SLUDGE TRANSPORTATION/SPILLS	SOILS	WATER QUALITY	AESTHETICS	LAND USE	SLUDGE PROCESSING	VEGETATION	DRINKING WATER	SLUDGE COMPOSITION	SECONDARY IMPACTS	FISH AND WILDLIFE	SLUDGE APPLICATION	ALTERNATIVES	SLUDGE DISPOSAL	HISTORIC PRESERVATION	SLUDGE REUSE	METEOROLOGY	FLOOD HAZARD	CONSTRUCTION IMPACTS	STATE PERMITS	DISPOSAL SITES
7/24	U.S. Department of Housing and Urban Development																			X							
7/31	U.S. Department of the Army Corps of Engineers	X	X				X	X	X	X				X						X							
8/7	U.S. Department of the Interior				X								X		X	X				X							X
8/17	U.S. Department of Agriculture Soil Conservation Service							X							X				X								X
7/27	Advisory Council on Historic Preservation																		X								
8/9	Intergovernmental Relations Division-Oregon State Clearinghouse																										
	Department of Fish and Wildlife						X																				
	Department of Land																			X							
	Department of Water Resources										X																
	Historic Preservation Office State Parks and Recreation Branch																										
7/13	Columbia Region Association of Governments		X				X					X								X							X

Table 32

Comment Received on
Draft Environmental Impact Statement

Date Received	From	FEDERAL POLICY	ENERGY	SLUDGE MARKET	AGRICULTURE	GROUNDWATER	SLUDGE TRANSPORTATION/SPILLS	SOILS	WATER QUALITY	AESTHETICS	LAND USE	SLUDGE PROCESSING	VEGETATION	DRINKING WATER	SLUDGE COMPOSITION	SECONDARY IMPACTS	FISH AND WILDLIFE	SLUDGE APPLICATION	ALTERNATIVES	SLUDGE DISPOSAL	HISTORIC PRESERVATION	SLUDGE REUSE	METEOROLOGY	FLOOD HAZARD	CONSTRUCTION IMPACTS	STATE PERMITS	DISPOSAL SITES
7/21	League of Women Voters of Portland	X					X					X			X				X								X
7/21	Resources Conservation Company						X					X			X												
7/21	CH ₂ M Hill						X												X								X
8/2	Arthur Forsyth Company											X								X							
8/7	The Land Use Research Institute						X												X								X
8/7	Oregon Environmental Council			X		X	X			X									X								
8/7	Resources Conservation Company	X	X								X									X							
8/11	Resources Conservation Company										X									X							
6/21	William B. Culham					X				X	X								X					X			X
8/9	Stan Kahn	X			X	X						X							X								X

OREGON DEPARTMENT FISH AND WILDLIFE

P. O. Box 284

Heppner, Oregon 97836

Karen J. Miller
Jones and Stokes Associates, Inc
600 S. W. Tenth Ave.
Suite 411C
Portland, Ore. 97205

Dear Karen:

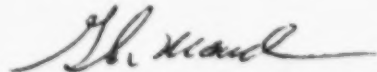
Enclosed are three pictures of the terns and gulls nesting at Three Mile Canyon along the Columbia River up from the mouth of Willow Creek.

I tried to find out the number of nesting birds that were using the area this year but both those men taking the inventory are on vacation and the info has not been filed. Approximately three thousand gulls and three hundred terns were nest^{ing} at Three Mile in 1977.

Also, the area where sludge was considered for disposal south of the Boardman Airport, 4,600 acres, is used by long-bill curlew for nesting. The U.S. Fish and Wildlife Service, Umatilla Refuge, Umatilla, Oregon, is conducting a curlew study and they should have additional information on curlew populations. Curlews show up around March 15th prior to nesting.

If any additional information can be provided, please contact me.

Sincerely,



Glen Ward, Fish and Wildlife Bio.
Ore. Dep't Fish and Wildlife
P.O. Box 284
Heppner, Ore. 97836 tel-676-9195

cc:La Grande Office
File

Response to Comments from G. Ward - Oregon Department of
Fish and Wildlife

1. Information included in EIS as suggested.



Executive Department

INTERGOVERNMENTAL RELATIONS DIVISION

ROOM 306, STATE LIBRARY BLDG., SALEM, OREGON 97310

August 8, 1978

RECEIVED
AUG 9 1978

ENVIRONMENTAL RELATIONS
DIVISION

Roger K. Mochnick, M/S 443
201 EIS Coordinator
U.S. Environmental Protection Agency
Region X
1200 Sixth Avenue
Seattle, WA. 98101

Dear Mr. Mochnick:

RE: Sewage Sludge Disposal
for City of Portland
PNRS 7806 4 610

Thank you for submitting your draft Environmental Impact Statement for State of Oregon review and comment.

Your draft was referred to the appropriate state agencies. The Departments of Fish & Wildlife, Lands, Water Resources and Historical Preservation offered the enclosed comments which should be addressed in preparation of your final Environmental Impact Statement.

We will expect to receive copies of the final statements as required by Council of Environmental Quality Guidelines.

Sincerely,

for *Kay F. Wilson*
Martin W. Loring,
Manager
Grants Coordination &
Management Section

MWL:wb

Enclosures



OREGON PROJECT NOTIFICATION AND REVIEW SYSTEM

STATE CLEARINGHOUSE

Intergovernmental Relations Division
240 Cottage Street S.E., Salem, Oregon 97310
Ph: 378-3732

PNRS STATE REVIEW

Project #: _____

Return Date: _____

JUL 28 1978

Handwritten notes:
V.D. 10 of 1
E.I.
Sign off
Date

ENVIRONMENTAL IMPACT REVIEW PROCEDURES

1. A response is required to all notices requesting environmental review.
2. OMB A-95 (Revised) provides for a 30-day extension of time, if necessary. If you cannot respond by the above return date, please call the State Clearinghouse to arrange for an extension.

ENVIRONMENTAL IMPACT REVIEW DRAFT STATEMENT

- () This project does not have significant environmental impact.
- () The environmental impact is adequately described.
- (X) We suggest that the following points be considered in the preparation of a Final Environmental Impact Statement regarding this project.
- () No comment.

REMARKS

Please see attached comments.

Agency FISA & W. 181.0 By William E. Pitney
247
ENVIRONMENTAL MANAGEMENT SECTION 8/4/78

OREGON DEPARTMENT OF FISH AND WILDLIFE

comments on the
Draft Environmental Impact Statement
for

Sewage Sludge Disposal for the City of Portland

PNRS 7806-4-610

The City of Portland Sewage Sludge Disposal Draft Environmental Impact Statement (DEIS) appears to adequately assess most fish and wildlife resource impacts.

The alternatives proposing barge conveyance of the liquid sludge to Morrow County (Alt.A) or to the North Willamette Valley Area (Alt.D) pose unnecessary environmental risks should an accident occur.

Consequently, it is recommended that Alternative C, which involves sludge drying and local reuse, be selected. This alternative would have the least environmental impacts on fish and wildlife resources.

Response to Comments from the Oregon Department of Fish and
Wildlife - July 28, 1978

1. Comments noted.



OREGON PROJECT NOTIFICATION AND REVIEW SYSTEM
STATE CLEARINGHOUSE

Intergovernmental Relations Division
240 Cottage Street S.E., Salem, Oregon 97310
Ph: 378-3732

PNRS STATE REVIEW

Project #: 7806 4 610

Return Date: _____

ENVIRONMENTAL IMPACT REVIEW PROCEDURES

1. A response is required to all notices requesting environmental review.
2. OMB A-95 (Revised) provides for a 30-day extension of time, if necessary. If you cannot respond by the above return date, please call the State Clearinghouse to arrange for an extension.

ENVIRONMENTAL IMPACT REVIEW
DRAFT STATEMENT

- () This project does not have significant environmental impact.
- () The environmental impact is adequately described.
- () We suggest that the following points be considered in the preparation of a Final Environmental Impact Statement regarding this project.
- () No comment.

REMARKS

RECEIVED
JUN 19 1978
DIVISION OF STATE LANDS

If the project would require the removal, fill or alteration of 50 cubic yards or more of material within the banks of the waterway(s), we urge the applicant to apply for state fill or removal permits well in advance of construction deadlines to prevent unnecessary project delays. Specific information on the need for permits may be obtained from the Division of State Lands' office at 1445 State Street, Salem, OR 97310. Phone 378-3805.

Thank you for the opportunity to comment on this project.

250

Agency Lands

Response to Comments from the Oregon State Department of
Lands - July 28, 1978

1. Comments noted.



OREGON PROJECT NOTIFICATION AND REVIEW SYSTEM

STATE CLEARINGHOUSE

Intergovernmental Relations Division
240 Cottage Street S.E., Salem, Oregon 97310
Ph: 378-3732

PNRS STATE REVIEW

Project #: 7506

Return Date: _____

ENVIRONMENTAL IMPACT REVIEW PROCEDURES

1. A response is required to all notices requesting environmental review.
2. OMB A-95 (Revised) provides for a 30-day extension of time, if necessary. If you cannot respond by the above return date, please call the State Clearinghouse to arrange for an extension.

ENVIRONMENTAL IMPACT REVIEW DRAFT STATEMENT

- () This project does not have significant environmental impact.
- () The environmental impact is adequately described.
- () We suggest that the following points be considered in the preparation of a Final Environmental Impact Statement regarding this project.
- () No comment.

REMARKS

1 | P.24. Flood Hazards

Some of the References on page 27 are outdated.

252

Agency

Water Resources By John Brumek

Response to Comments from the Oregon Department of Water
Resources - July 28, 1978

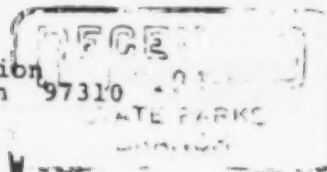
1. Available updated information included in EIS.



OREGON PROJECT NOTIFICATION AND REVIEW SYSTEM

STATE CLEARINGHOUSE

Intergovernmental Relations Division
240 Cottage Street S.E., Salem, Oregon 97310
Ph: 378-3732



PNRS STATE REVIEW

Project #: _____

Return Date: _____

ENVIRONMENTAL IMPACT REVIEW PROCEDURES

1. A response is required to all notices requesting environmental review.
2. OMB A-95 (Revised) provides for a 30-day extension of time, if necessary. If you cannot respond by the above return date, please call the State Clearinghouse to arrange for an extension.

ENVIRONMENTAL IMPACT REVIEW DRAFT STATEMENT

- () This project does not have significant environmental impact.
- () The environmental impact is adequately described.
- (X) We suggest that the following points be considered in the preparation of a Final Environmental Impact Statement regarding this project.
- () No comment.

REMARKS

An archeological survey was conducted for this proposed Sewage Sludge project for the City of Portland. (Appendix E)
A finding of no adverse impact was found for all locations except in the disposal site. The final site had not been chosen at the time of the survey. When the final location is chosen it should be inspected by a professional archeologist and a final statement of impact prepared for the final EIS.

HISTORIC PRESERVATION OFFICE
STATE PARKS & RECREATION BRANCH
525 TRADE STREET SE 254
SALEM, OREGON 97310

Agency _____

By _____

David C. Talbot

Response to Comments from the Oregon Historic Preservation
Office - July 28, 1978

1. Comments noted. A final site for sludge application in eastern Oregon has not been determined. Once an exact site has been chosen a professional archeologist will inspect the site as a condition of grant funding by the Environmental Protection Agency.

Advisory Council on
Historic Preservation
1522 K Street N.W.
Washington, D.C. 20005

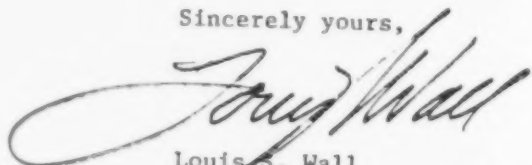
July 21, 1978

Mr. Roger K. Mochnick, M/S 443
201 EIS Coordinator
Environmental Protection Agency, Region X
1200 Sixth Avenue
Seattle, Washington 98101

Dear Mr. Mochnick:

This is in response to Donald Dubois' request of June 12, 1978, for comments on the draft environmental statement (DES) for Sewage Sludge Disposal for the City of Portland, Oregon. Pursuant to Section 102(2)(C) of the National Environmental Policy Act of 1969 and the Council's "Procedures for the Protection of Historic and Cultural Properties" (36 CFR Part 800), we have determined that this DES does not demonstrate compliance with Section 106 of the National Historic Preservation Act of 1966 (16 U.S.C. 470f, as amended, 90 Stat. 1320). However, it appears that the Environmental Protection Agency understands its responsibilities and will afford the Council an opportunity to comment pursuant to Section 106 if surveys of the disposal sites reveal cultural properties included in or eligible for inclusion in the National Register of Historic Places will be affected by the proposed undertaking. Accordingly, we look forward to working with EPA in accordance with the Procedures in the future, as appropriate.

Sincerely yours,



Louis S. Wall
Assistant Director, Office of
Review and Compliance, Denver

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JUL 27 1978

ENVIRONMENTAL EVALUATION
BRANCH

The Council is an independent unit of the Executive Branch of the Federal Government charged by the Act of October 15, 1966 to advise the President and Congress in the field of Historic Preservation.

Response to Comments from the Advisory Council on Historic
Preservation - July 21, 1978

1. Comments noted.

See Preface for EPA's grant condition regarding archaeological resources.

LEAGUE of WOMEN VOTERS of PORTLAND

610 DEKUM BUILDING 519 S.W. 3rd
TELEPHONE 228-1675
PORTLAND, OREGON 97204



Friday, July 21, 1978

City of Portland public hearing regarding sewerage sludge disposal

The League of Women Voters of Portland recommends Alternative A I as described in the Environmental Impact Statement for the disposal of sludge.

We have several reasons for proposing this alternative. First of all, for the long range, the question of availability of land and the acceptance by landowners to use the treated sludge on their land is of paramount importance.

The City and the EPA will naturally want to make sure their capital expenditures will prove worthwhile for the future. The Boardman area does seem to provide the largest inventory of land for sludge application as a soil nutrient, and to help reduce wind erosion. In addition, with a drier climate, the sludge may be applied during more months of the year. This might prove to be a severe problem in Clackamas County, where the climate is so much wetter.

Regarding both areas under consideration, The League believes that any concerns expressed by the residents should be taken into consideration.

Energy use and operating expenses tend to point favorably toward Alternative A I. With highways so clogged with traffic and truck accidents more prevalent, it seems environmentally unacceptable to have 39 round trips a day from the treatment plant lagoon to the Canby area. This will only add more pollution to our already overloaded airshed. The alternative transport means, barging up the Willamette, presents many problems too: low water, meandering river, heavy river traffic and small boats.

The B.E.S.T. process might have many advantages in our fertilizer hungry world, but at this time there seem to be too many unanswered questions involved in the process, not the least of which is the marketing problem. The companies already selling fertilizer might put up stiff resistance to competition that cost the customer nothing.

In conclusion, with 90% of the area's population connected to sewers in the year 2000, it behooves the City of Portland to plan immediately for the 90 tons per day of sludge that will have to be disposed of. To make the land disposal sites last even longer, we suggest that every effort be made by EPA regulation to cut down on the amount of zinc, cadmium and other metals that is allowed by companies to be put into the sewer system.

Leeanne G. MacColl
2620 S. W. Georgian Place
Portland, Ore. 97201
223-7664

Response to Comments from the League of Women Voters of
Portland - July 21, 1978

1. Comments noted.

RECEIVED
AUG 6 1978
PORTLAND SOLID WASTE

RM

Portland Solid Waste 1978

While the major focus of this paper will be disposal of Portland's sewage sludge, MSD's current solid waste plans will also be discussed since both suffer from the same basic flaws and both could and should be combined for most efficient and economic operation.

The Draft Environmental Impact Statement for Portland's sludge disposal describes barging the sludge to Morrow County, which would require 560,000 gallons of fuel a year as most likely alternative. According to EPA guidelines speculative price forecasting is not allowed in comparing the economics of the different possibilities. Be that as it may it remains folly to ignore the fact that the very large fuel price increases which all agree are 'imminent will drastically alter the economics of barging to Morrow County. MSD's resource recovery system is predicated on an endless supply of waste paper and plastic.

Packaging laws could/should be enacted to reduce the light fraction. If not then the marketplace will do the same thing. Plastic (derived from oil) and paper (from our denuded mountainsides) could easily become too valuable to throw away. In addition MSD will have 100 tons of boiler ash to dispose of which will be too toxic for landfilling.

There are several reasons why the composting alternative was deleted in the draft EIS. It is considered to be more expensive because it requires space, shelter and is labor intensive. In fact, a large part of the excessive cost estimates for the composting al-

has primary sludge trucked to the St. Johns landfill and secondary sludge barged to Morrow County, neither of which is necessary. Both can be composted right at the plant site. Even if composting is still more expensive than barging it can easily be seen that the factors that make composting expensive are likely to remain stable while the cost of fuel for barging is likely to skyrocket.

The greater part of the typical wastewater treatment process involves dewatering and settling of solids. Sewage ordinarily enters the plant with about 1% suspended solids. The methane digesters require at least 5 to 6% solids for efficient operation. A large part of the methane producing potential is now lost because of the low solids content.

The biodegradable portion (putrescibles, paper, brush) of the solid waste stream amounts to about ten times sewage solids. The addition of the biodegradables to the sewage as it enters the plant would accomplish the following; solids content would be ideal for the methane digesters, large amounts of gas would be produced (equivalent to cooking and hot water needs of 15000 homes), both primary and secondary sewage treatment (the greater part of the process) would be rendered unnecessary.

All of the regions biodegradable solid waste (about 70% of the total waste stream) could be handled in the space now occupied by our sewage treatment facilities. Many additional digesters would have to be built but should not require any more space than is now used for primary and secondary treatment.

Now of course we have much more to dispose of, nevertheless

the draft EIS estimates that potential users of free material would take seven times what Portland is now producing. Once again it is important to consider the cost of fossil fuels in todays decisions. Sewage sludge is much less concentrated than chemical fertilizer so it requires a lot more to apply the same amount of nutrients. Even so the rising cost of chemical farming will undoubtedly alter our present attitudes towards organics. Besides organics are far better for our soil.

Finally I would like to propose that the City of Portland in conjunction with the Portland School system establish urban farms as a learning experience for our children. These farms should be intensively managed, total about 2 to 3000 acres and be located in Rivergate or as close as possible to the sewage plants. Two thousand acres would provide the people of Portland with only about 2% of their total diet, but a substantial part of the in season vegetables, and they would always be reasonably priced. Above all it would be an invaluable experience for the kids.

Thank you,

Stan Kahn

Stan Kahn
722 SE 18
Port 97214

Response to Comments from S. Kahn - August 9, 1978

1. Comments noted.

RECEIVED
JUN 21 1978
EIS

1929 N. E. 10th
Portland, Oregon 97212
June 19, 1978

Roger K. Mochnick M/S 443
201 EIS Coordinator
US EPA Region X
1200 Sixth Ave.
Seattle Wash 98101

SUBJECT: EIS Sewage Sludge Disposl
City of Portland, Oregon

Dear Sirs:

The following comments on the Draft EIS Sewage Sludge
Disposal- City of Portland, Oregon are submitted.

Page 24 Rivergate Flood

1 The flood problem of the Rivergate Area has been
materially reduced by the improved control/ management
of upstream impoundments on the Columbia River System.
Possibility of a hundred year flood-- as in the past --
can be more accurately predicted, controlled and managed
so that any great damage could almost be eliminated and
a similar statement should be included in the EIS.

Also, if closure of the Columbia Slough to navigation
is accomplished, interior flooding behind the present
Columbia River levees will be reduced.

Pages 34-129 Rivergate Land Use Proposals.

2 As with any EIS, current and future planning and
land use conditions are in constant flux. This is true

of the Rivergate area and hinges on a recent action and decision of the Portland City Council. It is suggested that an "ADDENDUM" similar to the following be prepared and included in the EIS.

" ADDENDUM; Since the preparation of the EIS, the study by the City of Portland on dredging and use of Columbia Slough for navigation has been completed. Recent Council action accepted the recommendation of the City Engineer NOT to pursue any action to dredge the slough, but rather to close the mouth of the slough to navigation and keep the slough for drainage only.

This action is in concurrence with early plans of the Port of Portland to close the slough to navigation , and to further fill and develop more industrial land in the Rivergate area.

Also, the City of Portland and the Metropolitan Service District are actively pursuing the issuance of a permit by EPA and the Corps of Engineers to allow expansion of St. John's Refuse Disposal landfill in the Rivergate area.

Both of these actions may provide more acreage and an extended life expectancy for sludge application both on land filled with dredge spoil and the Refuse disposal site."

Page 130 Aesthetics

3 The statement regarding the "remoteness" of Morrow county sites when discussing remoteness and aesthetics is some what misleading. The transport of sludge by any means across I-80 N and the possible future development of areas along I-80 because of increased agriculture- industrial use by the reason the the PGE power plant and more irrigation may materially change the "remoteness" characteristic of the Morrow county sites within a short time.

GENERAL

It appears that future planning by local government and consideration of EPA and the Corps of Engineers of permits for dredge disposal and expansion of St Johns Refuse disposal site may offer some additional factors to be considered in the "NO ACTION ALTERNATIVE" for sludge disposal.

It also seems evident that a development plan for the Morrow county disposal sites for sludge must include the DISPOSAL concept as well as the land application and soil improvement program for sludge.

4 This is necessary because a major upset of the sewage treatment plant operation, changes in criteria for land loading of sewage sludge or changes in local land use peripheral to the land application areas may force a disposal program for sludge on either a short term or long term basis.

Consideration for sludge disposal could also include a joint program with PGE disposal of certain ash and residue from the coal-fired power plant.

266

Sincerely

William B. Culham
William B. Culham

Response to Comments from W. B. Culham - June 19, 1978

1. Information included as suggested.
2. Comments noted.
3. Comments noted.
4. Comments noted.



DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT
REGIONAL OFFICE
ARCADE PLAZA BUILDING, 1321 SECOND AVENUE
SEATTLE, WASHINGTON 98101
July 18, 1978

REGION X Office of Community
Planning and Development

R. 11

IN REPLY REFER TO:
10D M/S 317

Mr. Donald P. Dubois
Regional Administrator
U.S. Environmental Protection Agency
Region X
1200 Sixth Avenue
Seattle, Washington 98101

Dear Mr. Dubois:

We have reviewed the impact statement submitted with your June 12, 1978 letter.

The proposed project is to determine an acceptable sludge disposal or reuse program for the City of Portland.

We find no constructive comments to offer on any of the proposed alternatives. However, we do concur that no action alternative would certainly be a short term solution and would not be acceptable in meeting the future growth potentials of the city.

Thank you for the opportunity to comment.

Sincerely,


Mr. Robert C. Scalia,
Regional Director, CPD

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JUL 24 1978

ENVIRONMENTAL EVALUATION
BRANCH

AREA OFFICES
Portland, Oregon • Seattle, Washington • Anchorage, Alaska • Boise, Idaho
Insuring Office
Spokane, Washington

Response to Comments from the Department of Housing and Urban
Development - July 18, 1978

1. Comment noted.



THE LAND USE RESEARCH INSTITUTE

821 N.W. Flanders, Portland, Oregon 97209 503-222-4333

BOARD OF DIRECTORS

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Marine Biologist,
University of California, Berkeley

Mr. Roger K. Mochnick, M/S 443
201 E.I.S. Coordinator
U.S. Environmental Protection Agency, Region X
1200 Sixth Avenue
Seattle, Washington 98101

Re: City of Portland, Draft E.I.S.
regarding sewage sludge disposal.

Dear Mr. Mochnick:

The following is to support verbal comments made by myself at the public hearing held in Portland July 21, 1978 regarding the draft environmental impact statement pertaining to sewage sludge disposal alternatives available to the City of Portland.

As discussed, the upriver barging and agricultural utilization concept consistently presented and recommended by The Land Use Research Institute represents ten years of intensive investment and research on the part of private enterprise. Upon reviewing the draft E.I.S., it pleases us to note that this concept is one of the prime sludge management alternatives recommended by Portland's consultants. For this we are thankful and appreciate the fact that barging and utilization will now be given full consideration in any final decision making activities.

In summary, the Institute and its membership wish to offer their combined support for the barging and land application alternative. It is our belief that the coordinated efforts of the numerous segments of industry that the Institute has assembled for this purpose can reduce the final costs substantially over those shown in the draft E.I.S. cost comparisons.

As a matter of record, it was noted that the draft E.I.S. failed to include information presented by the Institute on behalf of industry at either the Dec. 9, 1977 or the March 3, 1978 public hearings on this subject. Because the information presented does speak in direct support of alternative A-1, we ask again

August 4, 1978

AUG 7 1978

ENVIRONMENTAL EVALUATION
BRANCH

that it be included in the final E.I.S. Copies of our Dec. 9, 1977 and March 3, 1978 statements which were read into the record at the time are attached.

Several members voiced surprise that this information was omitted from the draft E.I.S. and strongly urged that it not be ignored at this time. A majority of the technical information now available to the Institute membership was assembled over the past ten years by the consulting engineering firm of George D. Ward & Associates.

Funding for the longrange study was provided by an engineering retainer from Tidewater Barge Lines plus the \$1000 membership fees paid by the Institute participants. An appreciable amount of information and experience was also gained during almost three years and \$100,000 worth of sand dune stabilization research work conducted by George D. Ward & Associates on the 50,000 acre, U.S. Navy Bombing Range at Boardman. During that project, liquid sewage sludge was barged by Tidewater from Portland to Boardman where it was used successfully in establishing a healthy vegetative growth on massive, agriculturally destructive sand dunes. The project was successful and also demonstrated that sewage sludge can play an important role in preventing the loss by wind erosion of valuable agricultural top soil.

Those who supported the cost of The Land Use Research Institutes extensive study of alternate A-1, include the following:

- | | |
|---|--|
| 1. Tidewater Barge Lines | Columbia River & it's tributaries |
| 2. Land Reclamation Inc. | Operators of Portland Sanitary
Landfill |
| 3. Pacific Carbide & Alloys | Lime sterilization |
| 4. Dometac Chemicals | Line Sterilization |
| 5. Widning Transportation | Sludge tank trucks |
| 6. R. M. Wade | Irrigation equipment |
| 7. Morrison Oil | Own land adjacent to North Portland
Harbor and hold valid dock permit. |
| 8. Schulz Sanitary Service | Portland's largest septic tank
service organization. |
| 9. Eudaly Bros. Excavating | Skilled and equipped to construct
lagoons and sludge dredging. |
| 10. Mud Cat, Inc. | Manufacturers of sludge dredging
equipment. |
| 11. W. J. Bauer, Consulting
Engineers, Chicago | Experienced in lagoon cleaning,
pumping and rail haul of liquid
sludge. Engineering News Record
attached. |

In addition to the above, the Institute has made extensive contact with the agricultural communities along the full length of the Oregon and Washington shores of the Columbia from Portland to Pasco and to a lesser extent along the shores of the Snake River into Idaho. This has resulted in the establishment of potential contract agreements with numerous agricultural property owners amounting to many thousands of acres; far in excess of the

area required to serve The City of Portland.

Efforts to develop a three state, regional sludge utilization concept are continuing. The latest development has been an invitation by Dr. Joseph B. Farrell, Chief of E.P.A.'s Ultimate Disposal Section of the Environmental Research Laboratory in Cincinnati to submit a grant application for a two year sludge oriented research and development project. If awarded, it would include the investigation of lime sterilization of sludge, barge loading and off-loading methodology. The establishment of disposal research sites at various upriver locations and an accurate cost analysis of all aspects of sludge barging as compared to other known sludge hauling and disposal alternatives.

It is anticipated that work on the E.P.A. funded research project could get started in early 1979. If so, this would make the results available in time for either consideration or immediate implementation at approximately the same time as Portland's new digestors are completed and placed into service.

In conclusion, we trust it is apparent that private enterprise has demonstrated it's collective capability to properly receive, transport and utilize the City of Portland's entire output of sewage sludge through the year 2000.

Contract negotiations with willing land owners along the shores of the Columbia are continuing. Barge modifications are also being planned by Tidewater and several upriver off-loading points have already been established with dock construction underway at one site in Washington. For added economy a study is now underway to establish return haul cargos for full utilization of manpower and equipment.

This concludes the essence of my comments at the July 21 public hearing. I'd be pleased to answer any further questions you may have.

Respectfully submitted,



George D. Ward, P.E.

GOW:ly

Response to Comments from the Land Use Research Institute -
August 1, 1978

1. Comments noted. As requested by the city council on September 27, 1978, the City of Portland will consider proposals from private concerns for transportation and disposal of sewage sludge.



DEPARTMENT OF THE ARMY
PORTLAND DISTRICT CORPS OF ENGINEERS
P. O. BOX 2946
PORTLAND, OREGON 97208

NPPEN-PL-5

31 July 1978

Mr. Rodger Mochnick
EIS Coordinator
U.S. Environmental Protection Agency
Region X
1200 Sixth Avenue
Seattle, WA 98101

RECEIVED
AUG 7 1978
ENVIRONMENTAL EVALUATION

Dear Mr. Mochnick:

Please refer to your 12 June 1978 letter to all interested agencies, groups, and citizens for the review of the draft final Environmental Impact Statement (EIS) entitled "Sewage Sludge Disposal for the City of Portland, OR" (EPA 910/9-050). Since the Portland District Corps of Engineers was responsible for the CRAG area 208 Sludge Management Study, our office has reviewed your draft EIS. Our comments are attached.

Thank you for the opportunity to review this draft EIS.

Sincerely yours,

Patrick J. Keough
for PATRICK J. KEOUGH
Chief, Planning Branch

Incl
as

CF:

1. Mr. Terry Waldele, CRAG
2. Mr. John Vlastelicia, EPA Oregon Operations Office
3. Mr. Cowles Mallory, City of Portland

COMMENTS ON SLUDGE EIS

1 a) Pg. 14, Figure 4: The names for the potential disposal areas for Sandy, Estacada, Canby, and the Kellogg Region are labelled as "Disposal Sites" which is not correct. The areas were identified in our 208 report as "Potential sludge disposal areas." The label of "site" is misleading since the actual sites required for sludge disposal from those municipalities would be only small portions of the areas shown. Thus, it is recommended that the labelling on these areas be revised.

b) Pgs. 87-97: Marketing Analysis:

2 i) In general, the market analysis seems to be geared toward the fertilizer benefits rather than soil conditioning properties of a dried sludge product. Because it's nutrient value is relatively low, however, it seems that dried sludge should have been analyzed primarily as a soil conditioner and natural organic fertilizer. To quote Milorganite's selling phrase: "It can no longer be said that a pound of nitrogen is a pound of nitrogen irrespective of source." Also, since the Milorganite people have concentrated their marketing efforts of golf courses, parks, horticultural operations, and home-owners, it would seem that much of the effort should be around those potential markets. If this is not appropriate, the report should have summarized the reasons why.

3 ii) It would seem that the City itself could use much of the sludge on its own golf courses and parks. This could offset city fertilizer costs.

4 iii) The large difference in sludge volumes between the potential specialty product market in Table 15 and those in Table 16 for free material should be discussed. ie. -- What do the potential prices represent? How did the consultant arrive at these prices? How elastic is the demand with price changes? Since Milorganite is sold in the area at a relatively high price, it would be logical to assume that a Portland product could be sold at a lesser price in larger volume.

5 iv) Table 17 shows a potential market of only 3,000 tons @ \$30-\$40/ton for home and garden use of dried sludge as an organic fertilizer. How much milorganite sells in the local area at \$5.00 for a 50 lb. bag (\$200.00/ton)?

6 v) There seem to be no conclusions in the Market Analysis. As a minimum, the following two questions should be answered: Could the city sell this product? What would be the cost of a marketing system? As was shown in the 208 sludge study, the potential price of the dried product greatly influenced the ranking or cost effectiveness of the sludge drying alternative.

- 7 c) Pg. 104: on Table 18, indicates that the "short term" impacts of the no-action alternative are essentially negligible. However, there is no discussion of the potential serious long-term impacts of this alternative. A discussion of this alternative similar to the others on pgs. 81-84 would be very informative. Also, the potential huge energy consumption and generation losses from additional irrigation withdrawal from the John Day pool should be mentioned if land areas not presently irrigated are to be put under irrigation due to sludge applications.
- 8 d) Pg. 105, Energy Use: Somewhere in this section should be a comparison or documentation of the energy use of drying sludge vs. manufacturing a similar amount of commercial fertilizer.
- 9 e) Pg. 117, Odors: It is stated that barges will be inclosed to eliminate odor problems. However, if a barge is loaded for any length of time there may be methane gas production. This could be dangerous if not vented from the barges since methane and air is an explosive mixture.
- 10 f) Pg. 123, Sludge Conveyance Reliability: Mention should be made of potential barge accidents and other unforeseen events which could close the locks at a dam and disrupt all river traffic. Also, provisions must be made for an annual 2-week lock maintenance on the Columbia River Projects.
- g) Pg. 125, paragraphs 2 and 3: The calculations which show the oxygen depletion in the Columbia and Willamette Rivers should be explained in more detail since:
- 11 i) It's highly unlikely that a barge could spill its entire load in 10 minutes. A slow seepage would be more reasonable.
- ii) It is unlikely that effects of a complete barge dump in the Columbia could be found one mile below the accident let alone 5.5 to 6.5 days later downstream. If the spill occurred in the main stream of the Columbia, the spill could move 300 miles or more in 5 to 6 days. A recent pilot dredging test on in-water disposal of approximately 1000 cubic yards of Willamette River material with a high immediate oxygen demand could not be detected less than a mile downstream from the dumpsite. This is evidently due to the huge dilution and mixing potential of the Columbia River.
- iii) You may want to note that the worst conditions for a spill in the Portland harbor area would be during the Columbia River freshet when the Willamette River flow may actually stop in the harbor due to high water level in the Columbia.
- 12 h) Pg. 160, Barge or Truck Accidents: It is stated that the municipalities of the Dalles, and Boardman withdraw water from the Columbia and should be warned in case of a barge spill. The town, of Dallesport, not the Dalles, withdraws water from Columbia. Boardman should be of no concern since it is upstream from the proposed barge unloading facilities.

12

Further, this section of the EIS states that Portland and Wilsonville use the Willamette River as a source. Neither of these municipalities presently use the Willamette River as a source. Several Washington County purveyors have been recently considering the Willamette River as a source but no firm decisions have been made.

13

Since both our 208 study, the city's 201 study and this draft EIS showed that sludge disposal in the Northern Willamette Valley, Alternative D, would be more expensive and have more serious environmental, social, and institutional impacts than the other alternatives, it is assumed that it will be dropped from further consideration. This leaves Alternative A (barging to Boardman) and C (drying to a marketable product) for consideration and project recommendation. However, with unanswered questions on the market analysis study, it appears that recommending Alternative C would be difficult.

Response to Comments from the U. S. Army Corps of Engineers -
July 31, 1978

1. Corrections made as recommended.
2. The marketing analysis section in the Draft EIS was composed of excerpts of a preliminary report. A summary of the final marketing report is presented on pages 91-98. The final report clearly states that the primary value of the proposed dried sludge product would be as a soil amendment. There were three general markets identified and analyzed in the report: the home and garden market consisting of private households; the specialty market consisting of landscape contractors, wholesale nurseries, public agencies and other urban commercial users; and the commercial agricultural market. The demand in the first two markets is primarily for a soil amendment, although secondary markets for a base for organic fertilizers and a potting soil ingredient for home and garden use were also identified. No commercially feasible market was found in commercial agriculture.
3. School districts, parks and public works department demand is estimated and described in the final report. On a commercial basis the demand is very low as very little soil amendment is used and organic fertilizers require too much additional labor in application because of their low nutrient contents. If the product were provided free these public agencies would be willing to use between about 3,000 and 4,000 tons annually.
4. The final marketing report emphasizes the comparability of sludge as a soil amendment with wood by-products. Demand for a sludge as a soil amendment is a step-function in that prices above about \$7.50 per ton (June 1978 prices) were not found to be generally competitive with wood by-product prices, thus, captured a very small percentage of the market, but at \$6.75 to \$7.50 per ton, demand was substantially greater. Demand then apparently increases very slowly at prices under \$6.75 per ton until a price of zero is approached, at which point another substantial increase in demand occurs.

Milorganite is sold as a fertilizer (not a soil amendment) in the specialty and home and garden markets and is placed on the market at a relatively high price - even for a fertilizer of its analysis. However, estimates of local sales of Milorganite to these markets are not available so it is difficult to compare estimates made in this report to Milorganite's experience.

5. Again, estimates of local Milorganite sales are not readily available, but only 70,000 tons are sold annually and it is known that the most active market for Milorganite is in Florida citrus production. Current sales of organic-based fertilizers in the local areas are estimated at less than 1,000 tons annually. This market is growing, but sludge alone is not likely to capture a great percentage of that growth without fortification. The Nu-Life Fertilizer Company of Tacoma, for instance, uses Chicago's heat-dried sludge as a basis for many of its organic-based fertilizer products. Portland could compete in this market, but two of the major northwestern fertilizer manufacturers making organic products are closer to Seattle which is also considering heat-drying its sludge. The 3,000-ton estimate is conservative but realistic.
6. The marketing report clearly indicates there is sufficient demand to absorb all potential heat-dried sludge production by the City of Portland. Exact estimates of the potential return to the city from a sludge marketing program were not developed. Experience elsewhere indicates that returns are likely to be negative during the early years when the market is being developed and the product is gaining recognition. Given appropriate development such a program can produce positive net returns in later years though these returns would never approach the sludge drying costs. Marketing may still be desirable if it minimizes total sludge disposal costs.
7. A discussion of the no-action alternative, similar to discussions for Alternatives A-1, C-1 and D-1, D-2, is presented on pages 100-102. Discussion of the potentially serious long-term impacts of the no-action alternative is included in the section entitled Analysis of the Environmental Impacts of the Alternatives.

Land areas on the Boeing property not currently in agricultural use are planned for large-scale agricultural activities in the near future. In terms of a particular parcel of land, availability of sludge may cause a parcel to go into agriculture sooner than it would otherwise, or sludge availability may cause a parcel to go into production in substitution for another piece of land. Although sludge may assist agriculture through soil stabilization and fertilization, it is probably not the determining factor as to whether land goes into agriculture or not. Therefore, no analysis was made of the energy consumption or generation losses caused by additional water withdrawal from the John Day Pool.

8. The marketing study was not designed to develop the most cost-effective means of developing a commercial fertilizer. The goal and objective of the analysis was to find the most cost-effective method of sludge reuse. In this case, sludge reuse could supplement commercial fertilizer use, but not replace it. Therefore, the analysis suggested is not warranted.
9. Corrections made in text as suggested.
10. Additional information included as requested.
11. The analysis of oxygen depletion resulting from a sludge spill in the Willamette or Columbia River was predicated upon the worst conceivable hydrological situation in each river, which may not be realistic, but provides the reader with possible impacts under the worst river conditions. It would be reasonable to assume that within a short distance of even a massive sludge spill in the Columbia River, dispersion would be so great as to render the sludge undetectable. However, no study was conducted to evaluate the hydrologic mixing and dispersion characteristics of a spill in the Columbia River. Rapid dispersion was assumed.

Additional information included as requested.

12. Corrections made as requested. Boardman is included in the discussion of municipalities utilizing river water because off-loading sites could be located upstream of Boardman if sludge is utilized by agricultural concerns east of the Boeing property.
13. Comments noted.

COMMENTS OF THE OREGON ENVIRONMENTAL COUNCIL ON THE DRAFT
EIS, SEWAGE SLUDGE DISPOSAL FOR THE CITY OF PORTLAND, OREGON
August 3, 1978

The Oregon Environmental Council is a coalition of approximately 70 sportsman, planning, health, recreation and labor organizations and 3000 environmentally concerned Oregonians. After reading the DEIS we feel that the statement presents few alternatives which are compatible with maintaining an environment that is both safe and clean, long a concern of this group. The alternatives are described quite thoroughly in most respects. We feel, however, that the many questions which do arise are important enough to make us lend our support to the no-action alternative until these matters are resolved.

1. Because of sludge's extreme toxicity, and because a barge spill could occur either near or below the great blue heron rookery located near (page 33) the Clackamas-Marion County disposal site, studies should be made ascertaining the effects of sludge on these birds. The herons would probably be extremely sensitive to a spill on the river since they obtain their water from the Willamette. It would be important, therefore, to know how long an accident at the near-by off-loading docks would take to reach the rookery. Also, could the resulting clean up be completed quickly enough to prevent damage at this declared significant natural area?

2. Before considering marketing dried sludge as a fertilizer in the Portland area (page 73), one must consider that many farmers would buy a cheap sludge-based fertilizer solely for a high nitrogen yield without any concern for the potential problems of heavy metals. So, would it be possible to label heavy metal percentages on the package? What problems has Milorganite had with this?

3. The sludge drying beds mentioned on page 83 for the Morrow County site would probably emit odors, especially with the high evaporative rate there. How would these odors be eliminated, or at least controlled?

4. Since past "acceptable standards" for many heavy metals have been later found to be unacceptable and constitute a health hazard to humans, it is probable that the presently acceptable standards (e.g. as on page 138) will not be considered safe throughout the twenty-year life of the project. As a result, any disposal alternative that uses these wastes on lands for crops or grazing is to be looked on skeptically. Consequently, one must estimate what the safe future levels of these heavy metals, especially cadmium and zinc, will be throughout the life of the project. Can these estimates be safely made?

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5 | 5. The DEIS states on page 156 that "use of sludge on such crops as wheat, alfalfa and grass is considered acceptable ". Wouldn't heavy-metal-laden grass concentrate heavy metals into grazing cattle, thereby leading to humans getting high concentrations in their milk or meat?

6 | 6. To judge how much heavy metals have built up in the groundwater at the presently used Rivergate disposal site is important in predicting seepage into groundwater elsewhere. The DEIS states, on page 164, " there are no background data with which to compare these heavy metal concentrations and interpret the concentrations reported. " Couldn't these high, admittedly abnormal, heavy metal concentrations be compared to concentrations in groundwater across the river? Probably there the features would be similar to Rivergate, permitting a fair comparison. If conditions were different across the Columbia River, then a site across the Willamette, or even an unused area on the Rivergate property surely must be available for comparison .

7 | 7. Why hasn't the percentage of zinc and cadmium originating from the major industrial contributors of heavy metals been determined (page 131)? When will they be measured? Connected with this, the DEIS proposes putting more pressure on industry to increase source control so as to limit their input of heavy metals into the system. However, many firms prefer to take the easier and more economical alternative of paying fines and doing as little as possible. So, how could regulatory agencies put this pressure on? To what extent would this be effective?

We appreciate the opportunity to submit these comments and request that they be included in the final impact statement.

Oregon Environmental Council
2637 S.W. Water Ave
Portland, OR. 97201

Submitted to:

U.S. Environmental Protection Agency
Region X
1200 Sixth Avenue
Seattle, WN 98101

LJC/s

Response to Comments from the Oregon Environmental Council -
August 3, 1978

1. The great blue heron rookery mentioned in the Draft EIS is located on the Clackamas River upstream from potential off-loading sites on the Willamette River. Therefore there would be no adverse effect on this rookery by a sludge spill in the Willamette River.
2. Any large-scale use of dried sludge as a fertilizer by private farmers would be under supervision of the Oregon Department of Environmental Quality, which has set limits on heavy metal loading to soils used for agriculture (Table 25). As far as is known, Milorganite has had no problems relating to heavy metals.
3. Properly digested sludge should generate very little odor in a drying bed. To minimize odor problems, drying beds would be located away from developed areas. Winds would disperse any odors quickly. Chemicals could also be used to control odors, but were judged unnecessary.
4. It is possible that present "acceptable standards" for heavy metal loadings may be found unacceptable in the future. Therefore, those alternatives involving use of sludge on agricultural land should be looked upon with concern. Monitoring programs would provide additional information on present safe loading rates on a site-specific basis. However, there is no way to forecast safe future levels of heavy metals.
5. Grasses are considered suitable crops for sludge application because heavy metals do not accumulate in plant tissues. Of greater concern is potential transmission of pathogens to animals grazing on or feeding on vegetation that has been fertilized with liquid sludge. The Oregon Department of Environmental Quality has established safety measures, including provisions to cleanse the vegetation through irrigation or rainfall prior to use by cattle.
6. To adequately determine the effects of heavy metal seepage from sludge disposal in the Rivergate area, a monitoring program must be established providing background information from deep wells located away from the disposal site as well as from wells located within the disposal site. At the present time, no studies of this nature are being planned by the city or by the DEQ. No water quality data could be found within the Rivergate area with which to compare data collected from the disposal sites.

7. Data on percentages of zinc and cadmium originating from major industrial contributors were not included in the Draft EIS because the City of Portland, until recently, did not have equipment of proper sophistication to accurately measure zinc and cadmium levels. The city is currently measuring zinc and cadmium contributions on a point source basis. Influent to the treatment plant has also been analyzed for zinc and cadmium concentrations (Edmonds, pers. comm.).

At the present time, the majority of industries contributing heavy metals to the sewer system are in compliance with regulatory standards. The source control program is, for the most part, considered by the city to be effective in controlling these heavy metal contributions (Edmonds, pers. comm.).

UNITED STATES DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

1220 S. W. Third Avenue, 16th Floor, Portland, Oregon 97204

August 15, 1978

Mr. Roger K. Mochnick, M/S 443
201 EIS Coordinator
U. S. Environmental Protection Agency
Region X
1200 Sixth Avenue
Seattle, WA 98101

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ENVIRONMENTAL EVALUATION
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Dear Mr. Mochnick:

Thank you for the opportunity to review your draft environmental impact statement "Sewage Sludge Disposal for the City of Portland Oregon."

We have reviewed the document and submit the following comments for your consideration.

The document represents the findings of a very thorough study and presents all aspects pro and con on the subject. A good presentation of unresolved issues is provided on page 173.

1. Pages 16 and 127 state mean annual precipitation for the Morrow County Sites is five (5) to seven (7) inches. We could find no weather stations in "Climate and Man" or "Temperature and Water Balance for Oregon Weather Stations," Special Report 150, May 1963, Oregon Agricultural Experiment Station, Corvallis, Oregon, that were less than seven and one-half (7½) inches for this area. (Umatilla is 7.8", Arlington is 8.8", Ella (Morrow Co.) is 9.14", Morgan (Morrow Co.) is 8.04".
2. Page 16. "The evapotranspiration rate exceeds forty (40) inches in most years." According to Special Report 150 (see above), Arlington and Umatilla rarely exceed thirty (30) inches. The figure of forty (40) inches or more is from pan evaporation and evaporation from soils plus transpiration from plants would be a smaller figure.
3. Pages 148 and 156 - is a statement ". . . these soils are considered to be marginal for the production of wheat, grass and alfalfa." Page 156 follows up with: "The use of sludge for growing those crops would therefore represent a major benefit in terms of increased productivity." Based on statements on

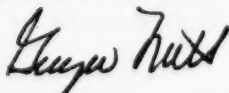


August 15, 1978

- 3 | pages 165, 35 and 37, the latter would be true only if the soils were irrigated, and under irrigation these soils, without sludge, are not marginal for the production of wheat, grass and alfalfa.
- 4 | 4. Page 92, first paragraph. There is an inference that sludge could be substituted for limestone because the sludge produced by the B.E.S.T. process has a pH of 9.4 to 10.4, which is due to the use of potassium hydroxide as a pretreat chemical. The use of this type of sludge was for the Willamette Valley. Calcium would have favorable effects other than amelioration of low pH. Some of these favorable properties are not associated with potassium.
- 5 | 5. Concerning heavy metals, pages 35, 36, 37, 135, 136, 147, 161 and 165. The two most limiting constituents are zinc and cadmium (page 161). The use of sewage sludge for growing root crops, such as potatoes, is unacceptable (pages 35 and 147). A considerable acreage is in a wheat/potato crop rotation. Alfalfa is grown in a rotation with wheat (page 35). Pasture is also grown in a rotation with alfalfa and wheat (page 35). If alfalfa and pasture are ever in a rotation with wheat and potatoes, the amount of acreage for sludge disposal may be quite limited. Is there a known timespan that is acceptable for growing potatoes after a sludge application on an earlier pasture or hay crop?
- 6 | 6. We found no discussion concerning the accumulation of heavy metals in the soils receiving sludge application that would reflect the variable of grazing versus harvesting of crops by other means. We believe the heavy metals will accumulate at a faster rate, other factors being equal, on grazed pasture than on land where these elements in a harvested crop are removed from the land. It should be possible to calculate zinc and cadmium budgets that will reflect this difference.

If you have questions concerning these comments, please contact us.

Sincerely,



Guy W. Nutt
State Conservationist

cc:

R. M. Davis, Administrator, SCS, Washington, DC
Director, Office of Federal Activities, EPA, Washington, DC

Response to Comments from the USDA Soil Conservation Service -
August 15, 1978

1. Correction made in text as requested.
2. Correction made in text as requested.
3. Correction made in text as requested.
4. Comments noted. After further consideration of the B.E.S.T. process, it appears that potassium hydroxide in dried sludge may not be an appropriate substitute for calcium carbonate.
5. Page 154 quotes from DEQ regulations that "no root crops or low-growing fruit and vegetable crops which are edible when raw should be grown on land fertilized with liquid sludge for a period of 1 calendar year from date of application".
6. No data are available to confirm this belief. Heavy metal accumulations would most likely be related to site-specific parameters such as crop type, weather conditions and soil types and would therefore require detailed analysis. A site-specific monitoring program would provide information of this nature.



CRAG

Columbia Region Association of Governments
527 S.W. Hall Street Portland, Oregon 97201 503/221-1646

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EPA-FIS

July 7, 1978

Mr. Roger K. Mochnick
"201" EIS Coordinator
U.S. Environmental Protection Agency
Region X
1200 Sixth Avenue
Seattle, Washington 98101

SUBJECT: Draft EIS Sewage Sludge Disposal for the City
of Portland, Oregon

Denton U. Kent
Executive Director

Regular Members
Clackamas County

Barlow
Canby
Estacada
Gladstone
Happy Valley
Johnson City
Lake Oswego
Milwaukie
Molalla
Oregon City
Rivergrove
Sandy
West Linn
Wilsonville

Multnomah County

Fairview
Gresham
Maywood Park
Portland
Troutdale
Wood Village

Washington County

Banks
Beaverton
Cornelius
Durham
Forest Grove
Gaston
Hillsboro
King City
North Plains
Sherwood
Tigard
Tualatin

Associate Members

Clark County
Vancouver

St. Helens
Port of Portland
Tri-Met
State of Oregon

Ex-Officio Member
State of Washington

Dear Mr. Mochnick:

The Columbia Region Association of Governments (CRAG) staff has reviewed the above referenced document and provides the following comments for your consideration:

1. The operation and maintenance cost listed for the BEST Sludge Drying System on table F-5 and F-8, pages 217 and 220, respectively, are incorrect. The appropriate cost should be \$1,507,000 as shown on page 216, not \$1,362,200. As a result, the total present worth of \$26,573,800 for sludge drying is incorrect.
2. Alternative A (barging to Morrow County) should be the favored alternative because the low cost, ease of implementation, beneficial impact as a soil conditioner and fertilizer outweigh the potential adverse impact of sludge spills and the short-term impacts of facility construction, assuming proper care is taken in the construction and operation of the facilities associated with this alternative.
3. Alternative C (Sludge Drying System) should be selected if a guaranteed market could be found which would significantly reduce the annual operating cost of the system. The BEST System appears to have the lowest capital cost. However, potential problems associated with the mechanical drying process, development of a market for the product, and disposal of the product if no market can be

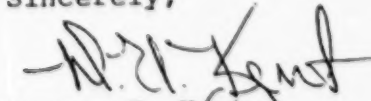
Roger K. Mochnick
July 7, 1978
Page 2

developed indicate the potential revenue should be significantly high to justify selection of this alternative.

- 2
- Alternative D (Land Application in Willamette Valley) is not recommended for consideration. Previous studies by the City of Portland and CRAG have rejected this alternative. The EIS identifies several significant adverse impacts including higher costs, institutional problems of dealing with 50 to 100 land owners for sludge disposal, aesthetic problems associated with a nine-acre sludge storage lagoon, and increased truck traffic with the associated air pollution and potential for sludge spills in the City of Portland and Clackamas County.
 - The "No Action" Alternative is not acceptable because of the short-term nature of this alternative and the potential health problems with disposal sites that are no longer available.

We encourage the Environmental Protection Agency to act promptly in supporting Alternative A or C by offering grant assistance to the City of Portland for construction of the ultimate sludge disposal facilities. If you have any questions regarding these comments, please contact Dan Hodge of our staff.

Sincerely,



Denton U. Kent
Executive Director

DUK:DH:bc:03
5/9-10

cc: John Vlastelicia, EPA Oregon Operations
Cowles Mallory, City of Portland

Response to Comments from the Columbia Region Association of
Governments - July 7, 1978

1. Corrections made as requested.
2. Comments noted.



21 July 1978

P11638.B0.90

Mr. Roger K. Mochnick
201 EIS Coordinator
U.S. Environmental Protection Agency
Region X
1200 Sixth Avenue
Seattle, Washington 98101

Subject: Draft EIS Sewage Sludge Disposal for
the City of Portland, Oregon

Dear Mr. Mochnick:

CH2M HILL, as consultant for Clackamas County, has reviewed the draft EIS and is pleased to see that this report has been revised since its preliminary form to better represent what a North Willamette Valley alternative (D) probably would look like. There still are a few minor points worth commenting on.

- 1 | • On page 166 the report indicates that there are 250,000 acres of suitable land in Clackamas County for sludge application. It should be emphasized that this is 250,000 acres containing suitable "soils" and that considering land use, roads, forests, etc., these are considerably fewer acres of land available for sludge application.
- 2 | • The location of the Willamette River barge unloading dock for Alternative D continues in this draft report to be located just south of Oregon City. Such a location would also infer that the storage lagoon would also be nearby. Such a location would tend to conflict with areas presently used and projected for further use by the Clackamas County plants. The unloading dock should probably be

Mr. Roger K. Mochnick
Page Two
21 July 1978
P11638.B0.90

2

located further upstream in order to be closer to the land that Portland should consider for sludge application. Also, the lagoon was indicated as being 9 acres in size which is drastically smaller than the City's facility plan originally indicated and undoubtedly much smaller than would be required.

3

Finally, Figure 7 has the Kellogg Creek plant mislocated and has omitted the Oak Lodge, Oregon City and both West Linn plants.

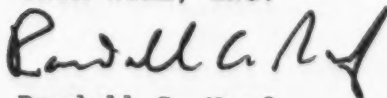
4

Reading the EIS report it is now evident that from environmental as well as economic reasons Alternative D should be rejected from further consideration. Also, as indicated in our review of the preliminary draft (Letter 10 March 1973), implementation of Alternative D would severely jeopardize the existing, successful land disposal operations carried out by the Oak Lodge and Oregon City plants as well as possible proposed operations for the Kellogg Creek and Tri-City plants.

Please contact us if you have any questions regarding these comments.

Sincerely,

CH2M HILL, INC.



Randall C. Naef
Project Engineer

RCN/h

cc: David Abraham
Jeanette Norman

Response to Comments from CH2M Hill - July 21, 1978

1. Correction made as requested.
2. Comment noted. The viability of Alternative D has been substantially reduced since publication of the Draft EIS; therefore, no attempt has been made to resize storage lagoons or locate more appropriate barge off-loading sites.
3. Corrections made as requested.
4. Comments noted.



United States Department of the Interior

OFFICE OF THE SECRETARY

PACIFIC NORTHWEST REGION

500 N.E. Multnomah Street, Suite 1692, Portland, Oregon 97232

August 4, 1978

ER-78/540

Mr. Roger K. Mochnick
201 EIS Coordinator
U. S. Environmental Protection Agency
1200 Sixth Avenue
Seattle, Washington 98101

RECEIVED
AUG 7 1978
ENVIRONMENTAL EVALUATION

Dear Mr. Mochnick:

This is in response to your request that the Department of the Interior review and comment on the Draft Environmental Statement for Sewage Sludge Disposal for the City of Portland, Oregon.

General Comments

Our review found that the draft statement, in general, adequately discusses the impacts of the project.

Specific Comments

Page 29, Fourth paragraph. The target area of the U. S. Navy Bombing Range, because it has been relatively undisturbed, contains many examples of native grasses and forbs which are fast disappearing elsewhere.

Page 31, Fishery Resources. Coho salmon should be included as a species of major importance upstream of Portland.

Page 33, fourth paragraph. The Fish and Wildlife Service is currently conducting a long-billed curlew nesting study in Eastern Oregon. The Navy Bombing Range is the major study site.

Page 113, first paragraph. Fish hatcheries on or close to the main stem Columbia in the area under consideration are Bonneville, Oxbow, and Cascade hatcheries in Oregon and Spring Creek and Little White Salmon hatcheries in Washington. The Washougal and Willard hatcheries are some distance upstream on tributaries.

2 | Page 128, last paragraph. The environmental statement should clearly indicate at least general plans for ground-water monitoring to accompany each alternative involving land application or disposal. This is perhaps implied by the discussion of monitoring required on some existing projects by the Oregon Department of Environmental Quality, but monitoring should be stipulated for the proposed action. Further, the statement should address the possible avenues of remedial action to be taken if contamination of ground water is detected. The potential for infiltration of contaminants from sludge in temporary storage lagoons--as under alternatives D-1 and D-2--should be addressed and mitigation proposed if necessary. References to additional monitoring projects of the Oregon DEQ are found on pages 138, 140, 163, and 164.

3 | Page 151, second paragraph. Displaced wildlife species are considered lost. Since adjacent habitats are normally at carrying capacity, introduction of displaced animals means eventual loss of the additional numbers of animals and, in extreme cases, reduction of carrying capacity.

4 | Page 157, Mitigation Measures. It is suggested that this section include mitigation for loss of wildlife habitat.

5 | Page 165, third and fourth paragraphs. The Fish and Wildlife Service believes that the target area portion of the U. S. Navy Bombing Range should not be used for sludge disposal due to the importance of this large acreage of native vegetation and the wildlife species dependent upon it.

Page 167, Unavoidable Adverse Impacts--Table

6 | Construction. The permanent loss of wildlife and wildlife habitat under alternatives A and D should be included in the table.

Sludge Disposal. Wildlife habitat should be included under alternative A since it is, in effect, lost as it is converted to habitat used by few wildlife species.

7 | Cultural Resources--Appendix E. Although an archeological survey has been completed which adequately addresses the possible effect of the pipelines and docks on cultural resources, the archeological values of the selected disposal area should be investigated. The disposal of sewage sludge may contaminate the site severely, limiting the scientific value of potential archeological resources.

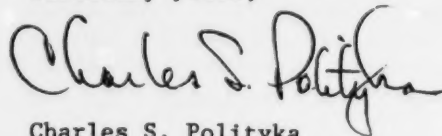
The procedure for the investigation should be determined in consultation with the Oregon State Historic Preservation Officer and documented in the final EIS. The procedure could, where appropriate, exclude significant

7

archeological areas as unsuitable for sludge disposal. The State Historic Preservation Officer for Oregon is Mr. David G. Talbot, Superintendent, Oregon State Parks, 525 Trade Street SE, Salem, Oregon 97310.

We appreciate the opportunity to review and comment on this document.

Sincerely yours,

A handwritten signature in dark ink, appearing to read "Charles S. Polityka". The signature is fluid and cursive, with the first name "Charles" being the most prominent.

Charles S. Polityka
Regional Environmental Officer

Response to Comments from the U. S. Department of the Interior -
August 4, 1978

1. Additional information and corrections included as requested.
2. The Environmental Protection Agency has determined that a groundwater survey will be necessary prior to the award of any Step 3 construction grant funds. The "Preface" page i outlines EPA's requirements.

The viability of Alternative D has been substantially reduced since publication of the Draft EIS; therefore, no attempt has been made to study this alternative in greater detail. In any event, it is likely that storage lagoons would be sealed to prevent any leakage of sludge contaminants to groundwater.

3. Corrections made as requested.
4. Because availability of sludge was not considered a determining factor in agricultural expansion on Boeing property, it was judged that regional losses of wildlife habitat attributable to this project would be minimal. Use of sludge to stabilize sand blows would possibly create new wildlife habitat.

As stated in the Summary, proposed off-loading sites and pipeline routes at Threemile and Sixmile Canyons have been dropped from consideration due to significant wildlife use of these areas.

5. Comments noted.
6. Corrections made as requested.
7. Comments noted.

Public Statement of Paul S. McGough, Vice President - Product Development,
Resources Conservation Co., Seattle, Washington

Ladies and gentlemen, my name is Paul S. McGough. I am Vice President - Product Development with Resources Conservation Co. RCC is the developer of the B.E.S.T. sludge-drying system in the analysis of alternate sludge disposal systems in the draft E.I.S.

Aside from some detailed corrections and comments to the draft which are contained in the appendix to this statement, it is my belief that the positive aspects of resource recovery by the beneficial use of sludge on land should be emphasized.

1 A review of the EIS draft leads persons who are resource recovery-oriented to commend both the City of Portland and the Environmental Protection Agency for the thorough effort made to explore means of beneficial use of sludge on land.

Our efforts in support of the City of Portland have been to provide what we believe to be a least-cost approach to dewatering and drying sludges, putting them into a form that is usable as a bulk organic fertilizer.

Pilot tests conducted in the past year have proven that economical dewatering and B.E.S.T. drying can be accomplished. B.E.S.T.-dried solids are granular, pathogen-free and free-flowing. Handling and transporting these solids present no environmental hazards.

The pilot tests also show that Portland sludges can be dried with minimal environmental impact and can provide the residents in the Portland service area a beneficial material.

1 Although the marketing analysis in this draft is not complete, especially the portion related to the value of product solids, we estimate that if each resident of the City of Portland were provided the opportunity to purchase a fifty pound bag of the product solids as an organic fertilizer, an approximate 20 percent reduction of the city's operating and maintenance cost of the entire sludge-handling system could be realized. Based on information obtained from regional and national fertilizer distributors, these products do have value and are in demand.

In any event, the solids marketing section included in the EIS draft should be developed in significant depth to ascertain the basic value of the dry solids and their most beneficial use. These recovered values to Portland could then be reflected in the economic evaluation for final alternate system selection.

This can be a great opportunity to establish a major milestone in promoting the national goal of resource recovery while providing the City of Portland an economical and environmentally sound method for sludge disposal.

APPENDIX

page 86, 2nd paragraph, line 8 - change 0.3 percent to 3.0 percent.

page 90, last paragraph, first line, change "A B.E.S.T. process type..." to read, "A dry...."

page 91, second paragraph, should add that one blender's use of 3,000 tons per year is 20 percent of initial solids output at Portland.

page 105, fourth paragraph, change 47 to 9.6.

2

page 106, Air Emissions, second line, delete hot air.

page 107, first paragraph, should read "...plus cooling water used in the...."

page 108, second paragraph, last sentence on pelletizing should be deleted. , B.E.S.T. solids will not require pelletizing.

page 129 - Alternative "C." Should read, "...odors would be most associated with non-condensibles being vented. Also, delete centrifuge and from line 3.

3

page 130, Alternative "C." This statement is incorrect. The B.E.S.T. solids are in granular form. The Carver-Greenfield solids are in a powder form, requiring pelletizing.

4

page 147, Alternative "C." It is not recommended that dry solids be landfilled. This is not the best use for these solids.

5

page 154, third paragraph, line 3, question the 15 percent nitrogen value. More likely five percent.

6

page 211. Present cost for electrical energy is \$0.0125/kWhr. Present cost for thermal energy is \$2.20/tef (actual gas).

7

page 216. EIS used 7 percent capital amortization versus 6 1/8 percent in Portland study. Is this correct?



RESOURCES CONSERVATION CO.
P.O. BOX 3766, SEATTLE, WASHINGTON 98124

RECEIVED

AUG 7 1978

August 3, 1978

ENVIRONMENTAL EVALUATION
BRANCH

Ms. Alexandra Smith
Chief, Environmental Evaluation Branch
Region X EPA Headquarters
Seattle, Washington 98101

Dear Ms. Smith:

The attached pages document our official comments to the draft Environmental Impact Statement related to Sewage Sludge Disposal for the City of Portland, Oregon.

In addition to these detailed comments, we would like to add for your consideration a concern we have with regard to the marketing section of the document.

8 The Environmental Protection Agency and other resource recovery-oriented groups are stressing the recovery and reuse of materials that have end-use value. Municipal sewage sludge is certainly such a material. The current draft EIS contends that the market for Portland sludges is the "local area." We do not concur in this position. Many of the cities that are currently drying and marketing their sludges are distributing the products outside the local area, and current indications are that the demand exceeds supply. Further, the products have sufficient value to sustain high transportation charges to get them to their ultimate markets. This is a current condition. As natural gas feedstocks become more scarce and thus more expensive, the market demand and hence price for organic fertilizers will significantly increase.

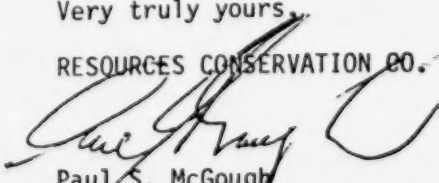
We would therefore strongly recommend that the market report be modified to consider the use of Portland sludge outside the local area.

I would like to take this opportunity to commend the persons from your office for the excellent manner in which this evaluation has been conducted. The City of Portland, Region X and the nation as a whole are better served because of a job so well done.

If you should have any questions concerning comments contained herein or about our process, please feel free to call me at any time.

Very truly yours,

RESOURCES CONSERVATION CO.


Paul S. McGough
Vice President - Product
Development

ATTACHMENT

9

- Page 86, second paragraph - The potassium level of B.E.S.T. dried solids would be 3.0% due to the use of KOH pretreat as compared with 0.3% for solids dried by conventional methods.
- Page 90, last paragraph - "A B.E.S.T. process type" should be changed to read "A dry" as this paragraph applies to dry solids produced by any method. Recognition should be given to B.E.S.T. solids' higher potassium level.
- Page 91, second paragraph - Reference should be made to the fact that 3,000 tons is 20% of Portland's annual output and thus represents a substantial commitment for disposal of dry solids.
- Page 105, fourth paragraph- The B.E.S.T. process requires 9.6 kWh/ton- not 47 kWh/ton.
- Page 106, Air Emissions Delete the words "hot air" as the B.E.S.T. process does not dry by using the "hot air" method.
- Page 107, first paragraph - Add the adjective "cooling" to water in the first sentence.
- Page 108, second paragraph- Delete references to pelletizing as B.E.S.T. solids do not require pelletizing. They are in a granular form as they come from the dryer.

- 9 | Page 129 - Alternative "C". The first sentence should read, "...odors would be most associated with the noncondensibles being vented." Delete reference to centrifuge from line 3.
- 10 | Page 130 - Alternative "C". This statement is incorrect. The B.E.S.T. solids are in granular form while the Carver-Greenfield solids are in a powder form (requiring pelletizing). There is a distinct difference in appearance and in form.
- 11 | Page 147 - Alternative "C". While dry solids can be landfilled, this is not a recommended use.
- 12 | Page 154, Third Paragraph - The 15 percent reference to nitrogen value is very high. A five percent figure would be more plausible.
- 13 | Page 211 - The present cost for electrical energy is \$0.0125/kWhr. The present cost for thermal energy is \$2.20/tcf (natural gas).



RESOURCES CONSERVATION CO.
P.O. BOX 3766, SEATTLE, WASHINGTON 98124

August 7, 1978

Ms. Alexandra Smith
Chief, Environmental Evaluation Branch
Region X EPA Headquarters
Seattle, Washington 98101

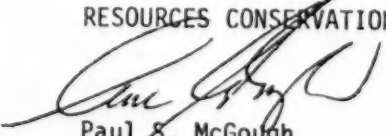
Dear Ms. Smith:

In addition to those comments sent you in my letter dated 3 August, 1978, please add the following:

- 14 | Page 73 - Third paragraph - Alternative C - Blended Digested Sludge Drying for Fertilizer Production.
First sentence should read
and dewatered using belt filter presses.
- 15 | Page 79 - Only one "C" (B.E.S.T.) alternative was proposed, which was C no subscript. All others should be deleted.
- 16 | Page 80 - Narrative description of C¹ should replace narrative description for C and C¹ and C² should be deleted.
- 17 | Page 85 - Figure 11 - Schematic Diagram for Alternative C¹.
Incorrect. Should be replaced with attached flow diagram.

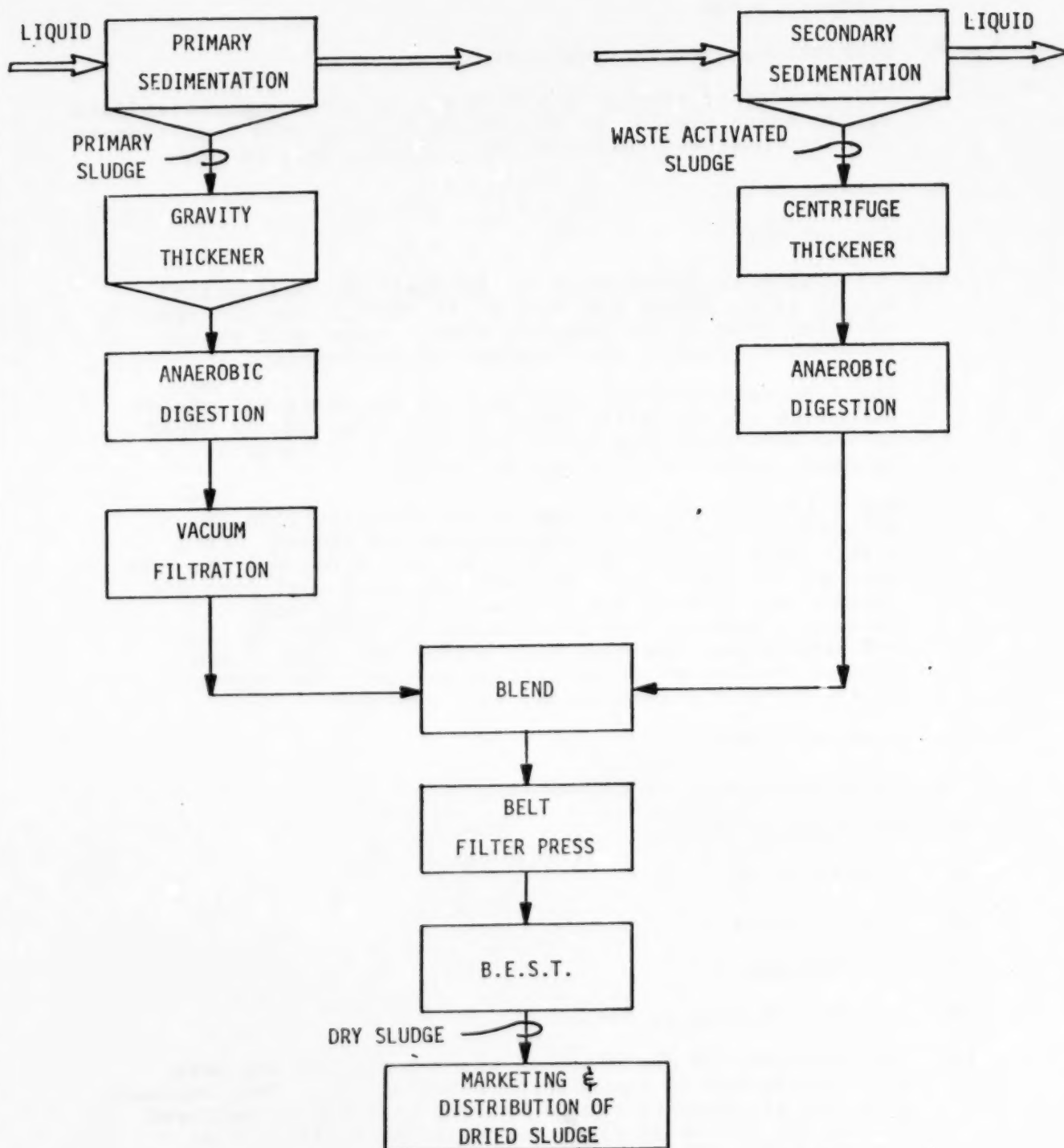
Very truly yours,

RESOURCES CONSERVATION CO.


Paul S. McGough
Vice President - Product
Development

PSM/jm
Attachment

SCHEMATIC DIAGRAM
FOR ALTERNATIVE C



Response to Comments from the Resource Conservation Company -
July 21, 1978

1. Comments noted.
2. Corrections made as requested.
3. This statement refers to both B.E.S.T. and Carver-Greenfield solids being similar in appearance to many soil conditioners. The text has been corrected to elucidate this point.
4. Comment noted.
5. Comment noted.
6. The unit cost values used in the Draft EIS (electrical energy at \$0.01/Kwh and fuel at \$1.90/tcf) are the same as those used in the Facility Plan. These unit values were not altered in the interest of consistency.
7. The 7 percent interest rate used in the Draft EIS was to establish the estimated costs to the city, and is based on the rate that many bonds have been sold recently. In other words, it is a typical value.

The 6 1/8 percent rate used in the Facility Plan is mandated by the EPA for determining the Present Worth Cost. This rate is now 6 5/8 percent, which was the rate used in the Draft EIS. The Present Worth Cost does not include any funding and is a measure of the cost to society. However, the local costs do include funding and assure that the city will borrow the local share through bonding or other similar method. The typical rate for municipal borrowing is 7 percent.
8. Comments noted.
9. Corrections made as requested.
10. See Response 3.
11. Comment noted.
12. Comment noted.
13. See Response 6.
14. Corrections made as requested.
15. The alternatives presented in the EIS are not and were not represented as recommended alternatives. They represent only the alternative sludge systems that were considered during the course of study for both the Facility Plan and the Draft EIS.

The specific alternative referred to by Mr. Paul S. McGough is described on page 238 of the Facility Plan and was considered during the facility planning study.

16. See Comment 15. Additionally, Alternative C-2 is described on page 250 of the Facility Plan. It too, was one of the many alternatives considered in this study.
17. Figure and text corrected as requested.

Arthur Forsyth Company

2035 Southwest 58th
Portland, Oregon 97221
(503) 297-3121

R M

August 2, 1978

Roger K. Mochnick, M/5443
201 EIS Coordinator
U.S. Environmental Protection Agency, Region X
1200 Sixth Ave.
Seattle, WA 98101

Subject: Response to Draft
EIS Sewage Sludge
Disposal for the City
of Portland, OR.

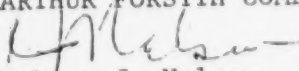
Dear Mr. Mochnick:

Enclosed are comments and questions from Dehydro-Tech Corporation regarding references in the Draft EIS to their Carver Greenfield process. Also we have included a copy of the L.A. City-LAOMA Pilot Plant Study and copies of equipment lists, capital costs and economics for Digested and Undigested sludge plants. This has been developed for Bergen County, New Jersey.

In addition, we have included a list of sludge plants which show a history of operation.

We appreciate the opportunity to present the attached information.

Very truly yours,
ARTHUR FORSYTH COMPANY


Robert J. Nelson

RJN/dw

Enc.

cc:Mr. C. Greenfield - Dehydro-Tech

RECEIVED
AUG 4 1978

ENVIRONMENTAL EVALUATION
BRANCH

REFERENCES TO ENVIRONMENTAL IMPACT STATEMENT
--DRAFT OF E.P.A.-JUNE 1978--

1. With reference to Alternative III - C1 Carver-Greenfield Process, we can establish Capital and O&M costs for the Portland operations similar to those we developed and described in our letter of October 14, 1976, with attachments of Capital and O&M costs. We do not know what Portland requires. Perhaps they are interested in obtaining LAOMA's view of costs.
2. The schematic diagram for Alternative C-1 - Figure 11 is entirely workable for the C-G Process as well as Figure 12 marked "Schematic Diagram for Carver-Greenfield Process Alternative. The Carver-Greenfield Process can also utilize vacuum filtration sludge which is shown in attachments sent to Portland on October 14, 1976.
3. Under the caption on page 86 of the report marked Carver-Greenfield Process, reference is made that the manufacturer claims that the water removed is virtually "distilled" in quality and "that considerable evidence exists to support the contrary". We do not fully understand this reference, but other than the water containing dissolved volatile organics the water with regards to salts and heavy metal content is of distilled grade. We have had samples of distilled water from our process that shows C.O.D.'s as low as 100 to 200. However, if sludges are septic or badly decomposed they can have values of up to 2000 or even higher. Our data indicates that a 1000 C.O.D. is typical. We further wish to emphasize that this water returned to the treatment plant is rapidly biologically oxidized without any significant treatment plant load. This can be verified by LAOMA. Further, such treatment can be utilized to produce a high quantity organic free and mineral free water equivalent to distilled water. We are enclosing the following references:

1. Los Angeles report
2. Dr. Farrels letter report

Further to the discussion of the Carver-Greenfield alternative on page 86, reference is made as follows: "After removal of the remaining oil, a portion of the dry solids are pyrolyzed to provide energy for the multi-effect evaporator". This is certainly true, however, in our economic studies described in our October 14, 1976 letter we did not pyrolyze any solids but assumed sufficient oil could be extracted by the process to provide the fuel and thereby the steam for the evaporator system. If we pyrolyze the dry solids the electrical energy costs would be zero and a substantial electrical energy quantity would be generated. We are enclosing data for a plant of 43.5 tons of digested sludge and 75 tons per day of undigested sludge showing the energy produced

- 4 | On page 87, a Cost Analysis caption is referred to for the Carver-Greenfield Process. Here, again, we are perplexed by the electrical generating equipment installation since no reference has been given for pyrolysis, gas turbine or steam turbine for generating electricity or credit given for electrical energy produced.
- 5 | --also see reference to energy requirements of the Carver-Greenfield Process on page 105.
- 6 | On page 107 under the caption Recycled Water, the Carver-Greenfield Process is referred to having oil remaining in the recycled water (back to the treatment plant). Utilizing a coalescer this oil is recovered and what remains is negligible. The water is clear and bright.
- 7 | On page 108 (top of page) we note the following: "The Carver-Greenfield Process has also had a short history of pilot plant application with no full experience handling sewage sludges." We are enclosing a list of plants which does describe a history of successful operating plants particularly Harshey, Fukuchiyama and Coors.
- 8 | On page 177 (on footnotes) reference is made to a San Francisco report of November 1977 on Carver-Greenfield Process. We are writing for a copy of this report. We wonder if the economics shown on page 218 and 219 are derived from this report.

Response to Comments from the Arthur Forsyth Company -
August 2, 1978

1. Comment noted.
2. Comment noted.
3. The information regarding the impurity of the water was based on the San Francisco wastewater solids study. Also, by virtue of the comments in this letter, the water is contaminated and therefore could not be considered "distilled".

The results of the pilot plant work at LAOMA and the letter of October 14, 1976, which is constantly referred to, were not available to the EIS consultant. We have no argument with the concentration of contaminants in the recycled water or that they are biodegradable. We are only trying to describe the process in relatively simple terms.

4. The electrical generating equipment is proposed for inclusion in several of the alternatives and is to be operated from the digester gas. It has nothing to do with the Carver-Greenfield process.
5. See Comment 4.
6. Comment noted.
7. The intent of the passage referred to was, "no full scale experience handling municipal sewage sludges". The Coors plant is a brewery waste. We are not familiar with the other two installations mentioned.
8. Comment noted.

Table 33

Public Hearing Testimony

Date Received	Speakers	FEDERAL POLICY	ENERGY	SLUDGE MARKET	AGRICULTURE	GROUNDWATER	SLUDGE TRANSPORTATION/SPILLS	SOILS	WATER QUALITY	AESTHETICS	LAND USE	SLUDGE PROCESSING	VEGETATION	DRINKING WATER	SLUDGE COMPOSITION	SECONDARY IMPACTS	FISH AND WILDLIFE	SLUDGE APPLICATION	ALTERNATIVES	SLUDGE DISPOSAL	HISTORIC PRESERVATION	SLUDGE REUSE	METEOROLOGY	FLOOD HAZARD	CONSTRUCTION IMPACTS	STATE PERMITS	DISPOSAL SITES
7/21	Paul S. McGough						X				X	X			X												
	Leeanne G. MacColl			X			X					X			X				X	X							
	George D. Ward	X		X	X		X	X							X				X	X			X				
7/20	Glenn Ward				X		X	X										X	X								

Public Hearing Summary

On July 20 and 21, 1978, the EPA held public hearings on the Draft EIS for the proposed City of Portland sewage sludge disposal system. The July 20 hearing, held in Boardman's high school, was attended by five people, while the July 21 hearing, conducted at Portland's city hall, was attended by about 20 people. Because of the costs involved, we have not reproduced the document for this Final EIS. A table is provided, however, which lists the speakers and the specific areas in which they were most concerned. The public hearing record is available for review at EPA's Oregon Operations Office in Portland and EPA's Region 10 Office in Seattle, Washington.

Following is a summary of the speakers' remarks at the two hearings:

The July 20 hearing in Boardman, Oregon:

Mr. Glenn Ward of the Oregon Department of Fish and Wildlife, was the only public participant at the hearing, and his remarks were made during the question and answer period. His questions and comments were primarily concerned with potential wildlife displacement and perturbation caused by the project, in particular the effect of an off-loading dock at Threemile Canyon near Boardman, on a population of Caspian terns and ring-billed gulls nesting there. As a result of Mr. Ward's reservations on the Threemile Canyon dock site, EPA has subsequently withdrawn that site from consideration.

The July 21 hearing in Portland, Oregon:

Mr. Paul S. McGough, vice president of Product Development for Resources Conservation Company (RCC), discussed sludge recovery and marketing for use as a bulk, organic fertilizer. Mr. McGough explained that pilot tests had proven the effectiveness of the B.E.S.T. process developed by RCC in producing an environmentally acceptable, indeed desirable product. He endorsed a reassessment of the marketing analysis, in particular the basic value and market demand of the dry solids and their impact on the economic evaluation for final alternative system selection.

Ms. Leanne G. MacCall, speaking for the League of Women Voters of Portland, recommended Alternative A-1 based on the following factors: 1) favorable land availability, climate for sludge application, and opportunity to enhance soil conservation in the Boardman area; 2) the economic and environmental unacceptability of alternative schemes. Ms. MacCall also suggested that EPA move to reduce the amount of heavy metals incoming to the sewer system from industry to the fullest extent possible.

Mr. George D. Ward, a consulting engineer representing the Land Use Research Institute, endorsed sludge conservation and utilization, especially with regard to upriver barging. Mr. Ward favored the interstate shipment of sludge to areas of need, indicating that the application of European methods of sludge concentration will brighten the prospects for its long-range transportation and will impact true barge economy. Ward recommends that the dispersement of sludge not be confined to a single disposal site, but be made available to those areas that need such material. On behalf of the Institute, Mr. Ward supported the City of Portland's objective, stressing upriver barging and agricultural utilization on a not-for-profit and not-for-cost basis. Ward also resubmitted two documents and added a third statement outlining the Institute's position and philosophy.

A brief question and answer period followed the speaker's presentation. Mr. McGough asked Mr. Bernhard, an economist for Gruen Gruen + Associates, the following questions:

1) if the value of product solids had been treated as a study topic; 2) if demand for it outstripped supply; and 3) if sale of the product solids versus a give-away program had been considered? Mr. Bernhard responded that product solid value had been discussed and that demand did exceed the potential output of sludge. He added that in considering just the free distribution of material, that this effectively lowered the "uncertainty" as to the ability to get rid of it.

EPA wishes to thank each of the participants at the public hearing for expressing their views and concerns. Additional information as a result of the hearing has been added to this Final EIS.